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Forthcoming Events.

MAY 29.

British Foundrymen's Association (Newcastle-on-Tyne Branch).—Annual meeting and general discussion.

JUNE 5.

British Foundrymen's Association.—Annual general meeting at Connaught Rooms, Kingsway, London, W.C., at 2.30 p.m.

NOTES AND COMMENTS.

Prohibited Exports of Foundry Iron.

About the middle of last month it was announced that the prohibition of the export of hematite iron to neutral countries without license had been made applicable to foundry pig-iron. This announcement created some stir in the iron trade, as, judging by the difficulties experienced since the war broke out in securing export licenses for hematite, it was considered that the prohibition would operate badly against iron makers. The effect of the Order so far has been not only to paralyse the already very small volume of foreign trade, but to depress values all round. Traders complain that the Order was issued without a moment's notice. The effect of the Order on the trade will, of course, depend in a very large measure upon the manner in which it is carried out by the authorities. If a real business-like attempt is made to deal with the applications for licenses without any unnecessary delay, the harm done may not be very great, but the experience in connection with the granting of licenses for hematite pig-iron is not encouraging. We are not entitled to complain at any step taken by the Government in the military interests of the State. But it must be confessed that the action of the authorities in this matter is not readily explicable. So far are the Germans from needing our foundry iron that they have been actually competing with us—and competing successfully—in neutral countries, notably in Italy. Our total exports of pig-iron, including hematite, during March to all neutral countries only amounted to about 7,500 tons, and if every ounce of that amount were smuggled into Germany it is difficult to see what material advantage it would be to our enemies. But it need hardly be said that already, before the issue of the Order, every possible precaution was being taken to ensure that the iron sent to neutral countries was for actual consumption therein. The Government Department concerned may be in possession of more information than we at present possess, and may have objects in view which cannot be made known, but the fact remains that the trade is completely in the dark on the subject. From the foundrymen's standpoint, however, the Order has a different significance, since it has acted as a check on the rising tendency of foundry irons.

Tool-Steel Makers and Tungsten Shortage.

It is common knowledge that the Sheffield makers of tool steel have of late been in an awkward position, owing to the shortage of high-grade tungsten powder, due to the stoppage of the German supply. Tool-steel makers dislike ferro-tungsten for their work, and the American tungsten powder is said to be too coarse, even if it were available, which it now is not. The works started by several Sheffield steel-makers have not yet succeeded in meeting the commercial requirements of the trade, though deliveries from the Thermo-Electric Corporation, Luton, appear to be imminent if they have not already started. It must not be supposed, however, that tungsten-powder manufacture is new to the country. As long ago as 1901 the Ger-

man monopoly was challenged by a British company, who set up a plant and made tungsten powder of from 96 to 98 per cent. purity. Manufacturers used this supply for some years, but as the result of a determined attempt by the Germans to oust British makers by price-cutting, the British firm, finding that steel makers were prepared to take German tungsten if it were a penny a pound the cheaper, dismantled their plant. When the war broke out, Sheffield manufacturers found themselves dependent entirely upon the German supply, and the question of re-erecting the plant was mooted. Eventually a plant for the work was laid down and, we understand, the first consignments of tungsten powder, showing under analysis a percentage only a fraction short of 98, have been despatched. This supply is small, of course, in view of the large demand, but the makers will probably be able to place larger quantities on the market soon. Other supplies also will doubtless materialise before the war is over. While it is to be hoped that Sheffield will not again allow itself to be placed in the humiliating position of having to depend upon Germany for what is almost an essential of its important high-speed steel industry, there is always a section of any trade that flies to the market which dangles a bait of a trifling reduction in price, regardless of what the ultimate result may be on the supply and its price. It is difficult to combat this tendency, but it is fundamentally unsound to encourage price cutting in any way which will tend to a monopolisation of the product. Time inevitably takes its revenge if such a process is permitted.

British and German Steel Metallurgy.

On the opposite page we reproduce some interesting abstracts from a recently issued pamphlet by Professor J. O. Arnold, who is well known as the Professor of Metallurgy at Sheffield University. The pamphlet appears to be intended partly as an answer to the suggestions recently put forward in many quarters to the effect that the British metallurgical industry is inclined to lag behind the German industry in the application of science and scientific methods. We have ourselves to some extent supported the same suggestion, in claiming that our industrial workers, from the rank and file upwards, are not sufficiently well and systematically trained to properly apply the scientific knowledge at present at the disposal of industry. This contention still holds good, despite the many cases which might be cited of well-trained and expert officers of industry emanating from Sheffield and other Universities and employed by a few progressive firms. In fact, such cases serve rather to throw into relief the necessity of a more general application of proper training.

History, of course, confirms Professor Arnold's statements regarding British contributions to the metallurgy of steel; and it will be admitted that Germany appears in relatively insignificant importance. Discussing a somewhat different matter, however, Professor Arnold expresses some indignation against certain critics of the British method of organising (we had almost said neglecting) technical education. Commenting on the German claim to supremacy, he says:—"At the same time it is only fair to Germany to state that their megalomania in connection with metallurgical science has been aided and abetted by many English public speakers, who, ignorant of the facts, in effect take up with reference to technical education the offensive German parrot-cry, 'Deutschland über alles.' A partial awakening, both of German and English educational dreamers, was brought about by an eminent and also honest German professor, who attended the Steel Congress in Sheffield in 1905. Commenting in the 'Cologne Gazette' on the metallurgical department of Sheffield University, Dr. Wedding said:—'The University has, in addition to its medical, philosophical, and philological faculties, also a very important department for applied sciences, viz., machine construction and metallurgy. Fifteen years ago a small pioneer institute for practical metallurgy had already been established, to which has now been added a complete plant for steel production, for the use of students. A small Bessemer converter, a 2-ton Siemens-Martin furnace, a cupola, hammers with re-heating furnaces, also gas and coke crucible furnaces, form the basis for a plant supplemented by numerous laboratories; such plant as is, in this form, totally unknown by us in Germany. With us the same purpose can only be obtained by the year of practical work laid down for students at German Technical Schools.'"

It is perhaps natural that one situated in a centre of metallurgy like Sheffield—one of the best equipped of all our cities in the matter of facilities for technical education—should lose sight of the fact that though results of research work are made known to the world, the actual facilities of the University are really available only to a few of those who might benefit thereby. Sheffield, Birmingham, Manchester and other big centres each continue their great work of metallurgical education year by year, and the results in the trade are no doubt appreciable; but surely Professor Arnold cannot mean that Sheffield University (or all the Universities in the Kingdom together, for that matter), affords adequate facilities for technical education. In the first place it is geographically inaccessible to the majority of students and workers, and in the second place its capacity, whatever results it may turn out, is too hopelessly small for the industry as a whole. We have no compunction in repeating the "parrot-cry" (as Professor Arnold would term it) of "technical education," and if at the same time the country is reminded that Germany has reaped untold benefit from the attention she has given to systematic technical schooling, we are not necessarily shouting "Deutschland über alles." Nor do we care to see eminent men attempting to lull the public back to their inglorious apathy on the question, in a belief that all is well because Sheffield possesses probably the finest metallurgical institution in Europe. Those who realise the importance of technical instruction (not only for the leaders of industry, but also for every grade whose work calls for intelligence and initiative) will continue to shout and shout again, until this country too realises the importance of the matter, and the utter inadequacy of our present system of training the workers for industry. It is not a question of a few central institutions for instruction and research work; it is a question of organising the schooling and training of the workers in industries so that they may become properly efficient and valuable units in the life of the State; and to pretend that any existing institution or collection of institutions meets the case is to side-track the whole issue.

On the question of research work, also, it would be interesting to know how many of our large metallurgical concerns actively participate in the same, or even apply for their own ends the results of published British researches. Bombast, egotistical and mendacious as many of Germany's claims undoubtedly are, one must admit that that country has not been slow to apply for her own ends the research work of any nation that provided it. Rivalries between British and foreign Universities, are at the best only of academic interest. What really concerns the country is the attitude of its vital industries to improvements, expansions and increased efficiencies.

British and German Steel Metallurgy.

In an interesting pamphlet* on "British and German Steel Metallurgy," Professor J. O. Arnold, F.R.S. (University of Sheffield), proceeds to show how much the development of steel metallurgy owes to British inventors and investigators, and how German practice has both been founded upon and has followed the lines laid down by British initiation. The pamphlet is, in the main, a refutal of the claim often put forward that German scientific research was foremost in the metallurgical field, and Professor Arnold proceeds to recall the following facts, which we quote from the pamphlet:—

"Up to 1740 all steel was made by hammering bar iron carburised by cementation, and was known as blister steel or shear steel according to the amount of forging work put upon the carburised bar iron. About 1740 the crucible fluid-steel process was invented in Sheffield by Benjamin Huntsman, of Doncaster, and in 1752 he commenced to manufacture on a considerable scale, so founding an industry destined to become permanent and world-wide. At the present time Krupps, at Essen, are making gun-steel ingots, each weighing 110 tons, by the process evolved from the brain of an Englishman 175 years ago.

"Robert Forrester Mushet, about 1858, discovered the remarkable influence on tool steel of the element tungsten, and up to about 1870 seems to have been patiently experimenting in the Forest of Dean. At the latter date he commenced to make 'Mushet Steel' on a considerable scale in Sheffield. Mushet's invention, although subjected to the discouraging predictions of Dr. Percy, of the Royal School of Mines, was destined to be the pioneer of a revolution in the art of cutting-metals. The plain carbon Huntsman type of steel, although after quenching from a red heat it possessed the hardness of rock crystal, was thermally unstable and completely broke down with the heat of friction at a temperature of 300 deg. C., thus reverting to its soft state. Mushet's tungsten steel, later fortified with a little chromium, was thermally much more stable and hence could be run at higher speeds with greater cuts and traverses on the lathe. The gradual development of the cutting power of Mushet's pioneer type of steel proceeded by cumulative improvements from 1880 to 1912; it was influenced in 1900 by the discovery in what is now the University of Sheffield of the astounding influence on steel of relatively small quantities of vanadium, an influence which, unlike that of tungsten, extended also to structural steels. In connection with the latter it was found that the elastic limit could be almost doubled without an undue sacrifice of toughness and ductility. By reducing the carbon in the original Mushet steel from 1.8 to 0.7 per cent., much increasing the tungsten and chromium, largely reducing the manganese, and adding 1 per cent. vanadium, the thermal stability of the cutting hardness was easily doubled, rising from 300 deg. C. to well over 600 deg. C. In fact, such steel can be run for several minutes cutting cleanly at a red heat, a proposition which, twenty years ago, would have been regarded as capable of enunciation only by a madman. The net result of the researches in British cutting-steels which were made between 1740 and 1912 has been in certain cases an improvement in cutting power of about 900 per cent.

"In the first half of the nineteenth century, the materials of construction for bridges were either cast or wrought irons. The materials for railway work were cast and wrought irons with a limited amount of costly crucible steel. Wrought-iron rails lasted about five years, steel rails last from fifteen to twenty years. Ship and boiler plates were exclusively of wrought iron, and the same remark applies to the early armour plates for battleships. In 1856 Henry Bessemer, a native of Hertfordshire, invented his pneumatic process for the purification of molten pig-iron. In the early sixties he started a works at Sheffield; other firms took up the process under royalties and the 'heavy' steel industry of Sheffield was thus founded. In most text-books and by many lecturers the Bessemer process has been hopelessly mis-described. Bessemer's blown and purified iron was so full of dissolved oxygen as to be absolutely useless for a commercial product, because it would not pour soundly nor would it forge at all, but fell to pieces under the hammer at a yellow forging heat. The process was made a success by an invention of Mushet for deoxidising molten iron by the addition of metallic manganese, which seized the oxygen dissolved in the iron and carried it up in the form of oxide of manganese into the supernatant slag. The process in its early days was not very satisfactory because insufficient manganese was used, the practice being to leave only about ¼ per cent. excess of manganese in the finished steel. Afterwards it was found that 1 per cent. excess manganese was necessary to obtain an easily forgeable steel. In justice the method should be called the Bessemer-Mushet process. This method long ago reached its zenith, and is now used mainly for making rails. It has been superseded by the open-hearth method, called on the Continent the Martin process, in England the Siemens method, or alternatively the Martin-Siemens or Siemens-Martin process. This method was made practicable by the invention of the regenerative heat system of the late Sir William Siemens, a British subject of German descent. In this process equal weights of pig-iron and scrap-steel are purified by the addition of solid oxygen in the form of red hematite ore. In acid-lined furnaces of this type 70 tons of steel are sometimes made at one operation. Mushet's deoxidising addition of manganese must also be used in this process, leaving about ½ per cent. of metallic manganese in the finished steel. Ingots upwards of 150 tons in weight are occasionally made in Sheffield armament works by this process.

"The advance of Germany into the position of the second steel-producing country of the world is due, not to her own 'Kultur,' but to an appropriation of the brains of British inventors, in fact, to the invention of the basic-steel process by Thomas and Gilchrist in England in the early eighties. This process made valuable for steel-making the hitherto useless phosphoric ores of Germany. Germany produced in 1909 over 12,000,000 tons of steel, and of these, over 7,500,000 tons were Thomas and Gilchrist basic steel, and over 151,000 tons were Bessemer's acid steel.* In this year Germany used over 25,500,000 tons of native basic ore, importing less than 8,500,000 tons of foreign ore.

"Considering the enormous debt due by Germany to British inventors, Britain owes very little to Ger-

* Oxford Pamphlets, published by Oxford University Press, London.

* The total was 18,958,000 tons in 1913, including 10,629 000 tons of basic converter steel and 155,000 tons of acid Bessemer steel. In 1914 the total declined to 14,973.000 tons, including 8,169,000 tons of basic converter steel and 100,000 tons of acid Bessemer steel — Editor, "F.T.J."

man initiative. Krupps, it is true, much improved the process for carburising the faces of armour plates, but on the other hand, they have had to adopt British improvements in armour-piercing shells. It is also true that in devising engines for blowing blast furnaces by the combustion of their own waste gases Germany has devised some admirable engines, but here again the idea of so using the gas came from the brain of a British furnace engineer, the late Mr. B. H. Thwaite, who died ill-rewarded for his pains.

"As to the comparative development during the last twenty-five years of German and British educational methods in teaching the applied science of steel, for purposes of comparison the steel departments at Charlottenburg and Sheffield may be selected. The latter has been contemptuously described by a professor of pure science as 'a pig-boiling and ingot-slinging establishment.' It is true that pig has been boiled into steel in the main practical laboratory at Sheffield University, and that casts of such steel up to nearly 2½ tons in weight have been made; also that the ingots have been slung out of the casting pit by means of a four-ton electric crane. Why not? It is also true that coke and gas crucible melting furnaces, and hardening furnaces of commercial manufacturing sizes are worked. There are also commercial mechanical testing machines for making static and dynamic tests. There is also a cupola for making in the foundry five tons of castings per day. Again, why not? To the examination of these products at every stage of manufacture, the pure sciences of mineralogy, chemistry, physics, and microscopy are applied to the fullest possible extent. Also it may be remarked that the University of Sheffield is unique in granting metallurgical degrees, namely, those of B.Met., M.Met., and D.Met. The Bachelor's degree requires a candidate after matriculation, in addition to seven applied science subjects, to pass also in three pure science subjects, namely, chemistry, geology and mineralogy, and either physics or mathematics. In the applied analytical chemistry of steel the German analysts are distinctly inferior to trained British chemists. At Charlottenburg there are no practical appliances whatever, and hence the science taught there is pure and abstract rather than applied and concrete. Which system is better for training officers to command the battalions of an industrial army?

"Take again, for instance, the microscopical analysis of the structure of metals. This science was founded by the late Dr. Henry Clifton Sorby, F.R.S., in Sheffield, in 1863-5, and his superb pioneer sections are still examined in the micrographic laboratory of the University of Sheffield. There are about twenty-nine constituents or sub-constituents of steel and iron. Of these twenty-six have been discovered in Sheffield, the steelopolis of Great Britain; three in Middlesbrough, its ironopolis; and the record of Charlottenburg in this branch of research is an absolute blank."

Classification of Commercial Copper.*

By Lawrence Addicks.

Any adequate classification of a material of commerce such as copper must take into account both the limitations of the metallurgical processes by which the material has been obtained and the needs of the manufacturing processes in which it is to be employed. The metallurgical methods depend in turn upon the nature of the ores or other sources of supply, and the manufacturing ones upon the ultimate uses of the finished product.

The uses for copper may be broadly classified as follows:—(*a*) Wire and other shapes for electrical purposes; (*b*) sheets and plates for non-electrical uses; (*c*) copper castings, generally for electrical use; (*d*) in alloys such as brass and bronze; (*e*) special purposes for which small quantities of alloyed impurities may be advantageous.

Electrical use immediately imposes a conductivity requirement which rules out everything but electrolytic and high-conductivity Lake, which are practically identical coppers. Most of the electrolytic refineries figure on averaging about 100.0 per cent. soft in the electrical conductivity of their outputs. Occasional lots may reach nearly to 101.0 per cent., and some may approach 99.0 per cent., while 98.5 per cent. is the usual rejection limit, but it is very unusual for a refinery to sell anything for electrical use which is below 99.0 per cent. No distinction is made between cakes, wire bars and ingots, more than one shape often being cast from a single furnace charge, so that there is nothing to be gained by ordering wire bars, and then cutting them up, when ingots are desired. Unless electrical use is specified it is customary to allow an additional leeway of 1 per cent. in conductivity to the refiner, but he rarely needs this, and prefers to maintain the higher standard, as copper is often resold several times before it comes into the hands of the actual user. As copper from a single furnace charge will carry practically uniform chemical impurities, deliveries on an individual order should be filled from as few furnace charges as possible, and all wire bars and cakes should be stamped with marks identifying these charges. The refiner will always consider complaints on a furnace charge basis if they are of a chemical nature. If they are indefinite he will generally investigate what other customers received copper from the charge complained of, and in the absence of other complaints will demand a bill of particulars before giving the matter serious consideration. The conductivity of a furnace charge is generally determined at the refinery several times while the charge is being cast, and this precaution together with the ample margin above rejection limits which is maintained, have practically abolished conductivity complaints.

When copper is not to be put to an electrical use, conductivity is of no special value except as a certificate of the absence of more than a trace of a certain class of impurities. The refiner divides impurities into three classes; those that depress conductivity, such as arsenic and antimony; those that impair ductility, such as lead, tellurium and bismuth; and those which are of value if reclaimed, such as silver, gold, platinum and palladium. The elements which depress conductivity are kept within bounds by the conductivity test regularly made. Those which are of value if reclaimed will never reach quantities sufficient to affect the physical properties of the copper, as it would pay to re-refine any such copper. The remaining class comprising elements which impair ductility is more difficult to deal with. We know that bismuth, lead, tellurium and probably selenium make copper very brittle even when present in very small quantities. We do not know, however, how to write a specification limiting these impurities, as the presence of small amounts of other impurities will neutralise their bad effects. We do know that amounts of lead up to 0.005 per cent. have no perceptible effect in mill practice or in alloys. Double this amount shows mild effects. Lead is about the only one of the group ever met with in sufficient quantity to be of interest.

* From a Paper read at the Chicago meeting of the American Institute of Metals.

Core Barrels.

By Sidney G. Smith.

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There are in use several types of core barrels, sometimes called core bars, that are more or less suitable for different kinds of work. The important question is as to which is the most suitable and economical one for a particular job; and in considering this matter, one must consider not only the initial cost of the barrel, but its upkeep afterwards. In large pipe foundries core barrels form a very costly item, and any change in design or material that tends to minimise the cost of production and maintenance is always welcome.

The time has not yet arrived when even straight socket and spigot pipes can be made without cores. Although experiments have been carried out in that direction, some years must elapse before the practice can become economically practicable, or generally adopted; and if success is attained it will be limited, so far as can be seen, to such castings. There would still be plenty of scope for other kinds, such as flange, lug, and bracketed pipes.

The writer's object at the moment is to give a practical description of the general working of various kinds of core barrels, collapsible and spring barrels included, in each case dealing with barrels that have passed through his own hands, both in making and working, under usual foundry conditions. The sketches have been made by the writer from barrels used in actual practice, and an endeavour has been made to give sufficient details of the general arrangement for practical working. The design of the spring barrel illustrated, which has the double-V wedge-shape bearings on the liberating key, is by the writer.

Before going into the details of large barrels, brief reference will be made to small core barrels. For 2-in. and 3-in. core barrels for castings 6 ft. and 9 ft. long, both wrought and cast iron are used. Above that diameter cast iron is the rule, unless they are for castings 5 in. in diameter and exceed 12 ft. long. For jobbing work in short lengths, say, from 2 ft. to 4 ft. long, and up to 18 in. diameter, wrought iron is the most economical on account of its lightness and durability, the thickness of such bars varying from $\frac{1}{8}$ to $\frac{1}{4}$ in.

In the case of core barrels for pipes 9 to 12 ft. long that are cast in a horizontal or inclined position, either loose hay, straw, chip-shavings, or bands made of such materials, are generally put on the barrels before the loam is applied, which is partly to assist the air to escape into the vent holes provided in the barrel and partly to make it easy to draw the barrel when contraction comes on the pipe after casting.

With castings that are poured in a vertical position loose hay and bands are dispensed with as far as possible. Barrels up to 24 in. in diameter are called "solid" barrels; not that they are actually solid, the term being used only to distinguish between such barrels and spring-key or collapsible barrels. These so-called solid barrels, which are hollow, are sometimes of a fluted design, but generally they are plain, strong barrels of good thickness, with abundant vent holes cast in. No bands or hay of any kind is used upon these barrels. The material, or stuff, applied for the first coating or roughing is of a very open, spongy and perishable nature, the composition, preparation and application of which will be discussed later. The striking or finishing loam used for these barrels is of ordinary composition, with extra opening material added.

The foregoing refers only to up-to-date pipe-foundry practice, where nearly all straight pipes, such as flange, lug, bracket, socket and spigot pipes, are cast vertically.

With the class of work now under consideration, which includes pipes from 3-in. diameter by 9-ft. long, to pipes 24-in. diameter by up to 13 ft. $1\frac{1}{4}$ in. long, the barrels are drawn as soon as possible after the metal in the mould has solidified. The reason for this is obvious. As soon as the metal is set the contraction (in these pipes especially) comes on fairly quickly, and nips the barrel so tightly that it may be impossible to draw it. With barrels, say, from 12 in. diameter up to 24 in diameter, which sometimes become fast, owing either to being left too long after casting, or to the core not being properly made and dried, a compressed-air or hydraulic apparatus of the lifting "jack" type, is put on top of the box, and with a series of lifting jerks the barrel is "started," and can afterwards be drawn in the usual way.

The thickness of loam allowed on the smaller barrels varies from $\frac{1}{4}$ in. to $\frac{3}{4}$ in. upon either side. Thus a 4-in. barrel for 12 ft. long socket-and-spigot pipes would be about 14 ft. long over all, with about $\frac{1}{4}$-in. taper from the top of the seat to the top of the head, and the thickness of metal in the barrel would vary from $\frac{3}{8}$ in. to $\frac{1}{2}$ in. It must be understood that all these pipes are cast socket down. The exceptions to this rule are very rare in modern British pipe-shop practice. The larger the barrel the greater the thickness in section, until about one inch is reached; also the thickness of loam on either side increases until about $\frac{7}{8}$ in. is reached.

Core barrels for pipes above 24-in. diameter may be either segment, spring or hinge types. The former (the segment barrel) has no key, and is entirely collapsible. Both spring and hinge barrels have a liberating key.

The first of the four types about to be described was designed by the writer. Its simplicity and economy will be apparent when compared with the barrels described later. Its efficiency as a practical working barrel cannot be questioned, as there is less about it to get out of order or require attention than with any barrel known to the writer. In the United Kingdom types of spring and collapsible barrels for large pipes are fairly well known, and are in general use in up-to-date foundries. How far this applies to America and the Continent is not known to the writer, and in view of this the details of the first type will for clearness be given somewhat fully.

It is difficult to comprehend how, in this country, we could now make large castings other than by using spring or collapsible barrels. The expense of rope-banded core barrels and the time spent in that operation, coupled with the extra drying, entirely puts that method out of consideration. But quite apart from that there exists to-day an exacting inspection which demands that the inside of these castings shall be as smooth as though the pipes were bored out in

a machine. It is impossible to regularly obtain this smoothness when using rope-banded barrels in vertically-cast pipes of thick section 12 ft. long.

Double-Vee Bearing Key Barrel.

The general arrangement of this barrel (shown in Fig. 1) is very simple. The sizes and other particulars relating to details are given in the sketches herewith, so that the latter form practical working drawings, although perhaps some small matters may require determining in individual cases. There are no other barrels with similar bearings and key in use. The shell, which is dimensioned for a 42in. barrel, should be made in loam vertically. That is the simplest and most economical method. It is the custom of the writer to make all core barrels for pipes 40 in. diameter and upwards in that way. Once the mould is bricked and rammed in the casings, any number of barrels can be made without disturbing the brickwork. The striking boards, etc., are the same as those used in ordinary loam-work practice. This method is far preferable to casting in the horizontal position in sand; the casting will be true in section and altogether cleaner in every respect.

In addition to the vent holes, all holes for the four bearing brackets, top and bottom, centre brackets, and the two hanging irons, should be cast in the shell. This obviates the necessity of drilling any holes whatever, which drilling would take up much time on the drilling machine. It is quite simply done by means of templates and accurate measurements; when the last striking of the barrel mould is par-dried or stiffened, the holes can then be cut out for insertion of the cores when dried.

An examination of the principle of the barrel will

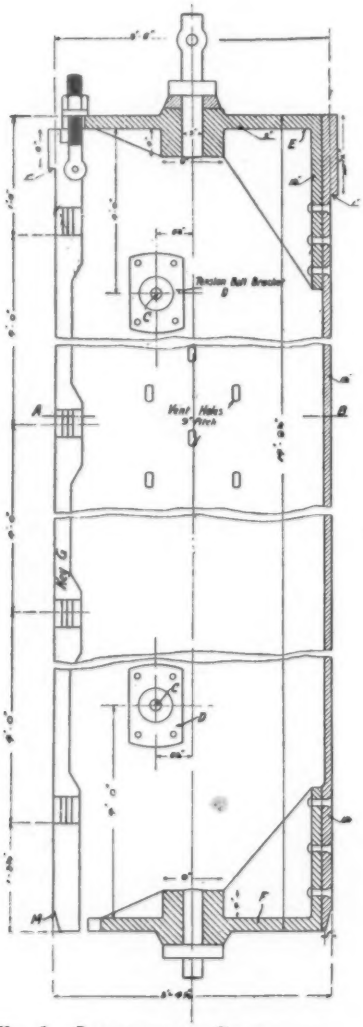


Fig 1.—Longitudinal Section of Assembled Barrel and Key.

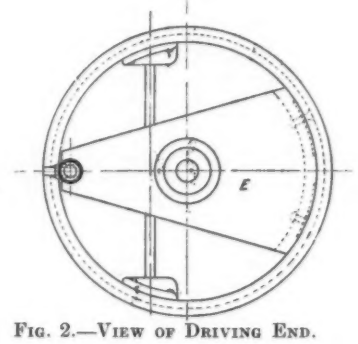


Fig. 2.—View of Driving End.

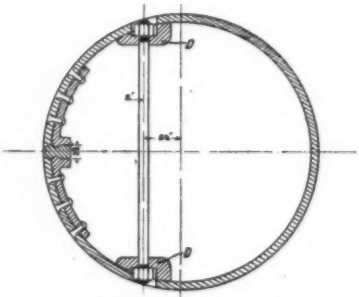


Fig. 3.—Section on A—B.

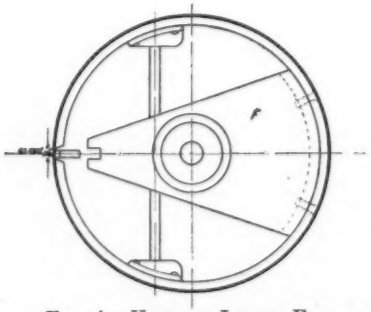


Fig. 4.—View of Lower End.

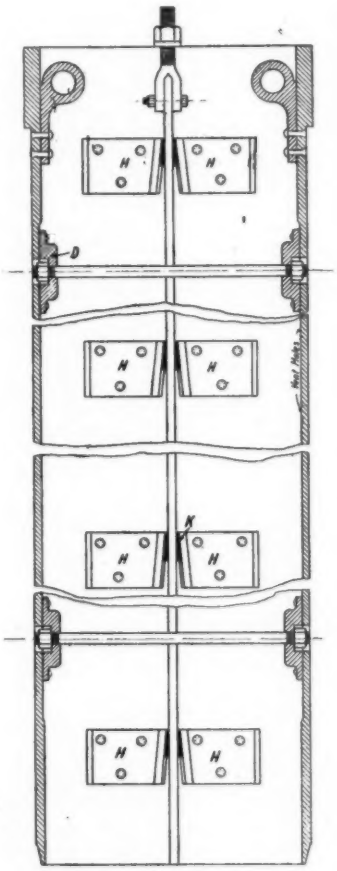


Fig. 5.—Longitudinal Section Showing Bearing Brackets.

Details of Double-vee Bearing Key Barrel.

show that no spring rings are attached; all the spring needed is in the shell itself, aided by the pull inwards when the chains, which should be short, are attached to the lifting irons, when drawing the barrel. The spring in the barrel is derived from the fact that the barrel shell is sprung outwards ¾ in. larger than when cast. This is done when finally fixing the key, which is about the last thing to do when fitting up. The shell is made with the keyway cast in ¾-in. smaller than the web fitting part of the liberating key. The method of doing this is the same as that followed when making any type of key barrel, *i.e.*, to ensure keeping the barrel diametrically round when cast, the keyway-aperture core, which

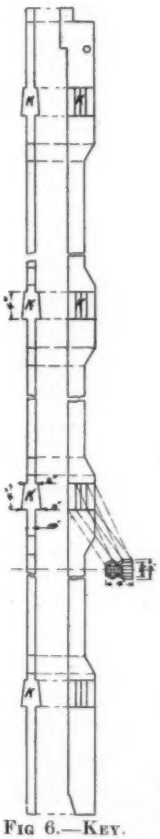


Fig 6.—Key.

Fig. 7.—View at Keyway of Barrel.

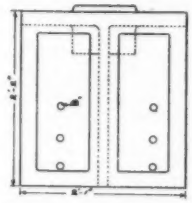


Fig. 8.—Top Centre Bracket E.

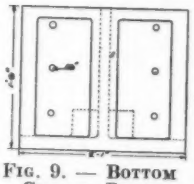


Fig. 9. — Bottom Centre Bracket, F.

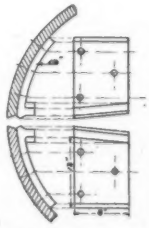


Fig. 10.—Bearing Brackets H, H.

is attached to the main body core of the barrel, is at intervals of about 3 ft. bridged through the thickness of the barrel by 2½ in. wide (see Fig. 15). These small bridges are not cut out of the barrel until the key is ready to be tried in its proper position when fitting up the barrel.

At first sight it may appear that when the shell is sprung outwards ¾ in. the barrel will not be round when the key is in position; but practice has shown that this is not the case, and that when the barrel is fitted up, it is quite round. The liberating key, which can be made of cast iron but preferably of cast steel, is held in position by a threaded bolt, the nut of which when screwed rests on a washer which covers the aperture provided on the top centre bracket. Details of this bolt are given in Fig. 11.

When a casting has been poured a certain time, which must be determined according to thickness, the nut is unscrewed to the level of the top of the bolt. The key should then fall about 4 to 5 in. and be held there in suspension by the nut taking the weight of the key, resting on the washer on the centre bracket. As the key falls it will go slightly inwards, the wedge shape double-vee bearings giving it this direction, which is necessary for a clearance at the top of the core seat or print, which is tapered at the bottom of key shown at M. The shell of the barrel is now at liberty to come inwards about ¼ in., which should be ample for drawing the barrel at the proper time.

It is important with any type of key barrel that the time between casting and drawing the barrel be strictly recognised and adhered to; if not, any type of barrel, no matter how good its design may be, will become fast if the contraction of the pipe is permitted to unduly come on the core. For instance, if the casting be ¾ in. thick, not more than 15 minutes should be allowed after pouring, when the key should be liberated, knocked down and the barrel drawn. If the casting be an inch thick, not more than 20 minutes; if 1¼ in. thick, 25 minutes; and if 1½ in. thick, not more than 35 minutes should be allowed. The time in each case should be regarded as the maximum, and in each case five minutes less than the time stated should be the minimum. The above is pipe-shop practice, and to prevent delays occurring from fast barrels must be strictly adhered to. There is no barrel yet made without roping that can stand the full contraction of a 42-in. diameter pipe without becoming fast, and if the diameter goes higher than that, and the thickness is not more than 1 in., the probability is that the pipe will fracture before it is cold.

Returning again to the key, it will be noted that the length of the bearings on the key is 4 in. (see Fig. 6, K), which of course is cast on the key, while the length of the corresponding bearing on the shell, which is formed by brackets bolted on to the shell, is 8 in. in length (see Fig. 7 and H Fig. 5). Thus when the key has fallen to its limit, say 5 in., it is still in its guide and line for returning to position after the barrel is drawn, as shown clearly in the view Fig. 5, H and K. This should prove convenient because when the barrel is laid horizontally after drawing, turning the nut will bring the key back to position. There is another way of doing this, viz., by allowing the weight of the barrel while slung in the crane perpendicularly after drawing, to rest on the key, or bump it up into its place, but this method may or may not sometimes be troublesome and not always successful.

When the barrel is being drawn, the chains slung on to the lifting irons in Fig. 5, and detailed in Fig. 12, should be as short as possible, just clearing the top of the centre bracket journal. This materially assists the barrel to fall inwards when drawing. Each top and bottom centre bracket (Figs. 2, 4, 8 and 9), E and F is cast in one piece, the hole being cast in for the journal. The hole is bored and the journal turned, driven in and pinned through the boss of the bracket, as shown. Figs. 2 and 4 also give end views of the barrel. Fig. 3 shows a cross-section at A—B, also of the tension bolt, situated towards either end of the barrel at C, Fig. 1. The bolt is arranged straight through the barrel 5¼ in. off the centre line, and is necessary for keeping the barrel rigid when expanded. It will be seen that holes in the barrel are sufficiently large for the nut at either end to pass through on to the bolt. The nut is

tightened on to the internal brackets D, D. These brackets are rivetted on to the shell, as shown. The nuts require tightening occasionally when the barrel is in constant use; this is only done after the barrel is expanded, and the liberating key being in position, it is but a moment's work with a box key, and gives rigidity to the barrel and prevents any undue vibration occurring.

The cross-section of the bearings, which are four in number, is also shown in Fig. 3, and the details in Figs. 10 and 14. The bearing brackets, right- and left-hand, H,H, are rivetted on the shell. The angles and taper of the double-vee bearings must be determined from full-sized lines, and sufficient taper must be allowed for the shell at the key-way to come in ¾ in. when the liberating key has fallen 4 to 5 in. A detailed section of the key bearing is shown in Fig. 14.

When laying out a core barrel of the size and design now under consideration, some of the essential points to remember are that a 42-in. diameter bore needs a 42¼-in. diameter core; a 42-in. core barrel should be 41 in. diameter when expanded; a 42-in. barrel should be 40 in. when cast; a 42-in. diameter core-barrel mould should be 40¼ in. diameter before casting.

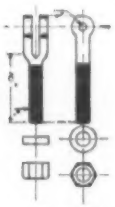


Fig. 11.—Hanging Bolt for Key.

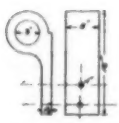


Fig. 12.—Hanging Irons for Top End of Barrel.

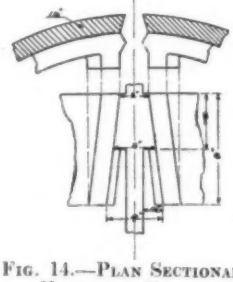


Fig. 14.—Plan Sectional View and Elevation showing Key in Position.

Fig. 13.—Tension Bolt and Bracket (C and D, Figs. 1 and 5).

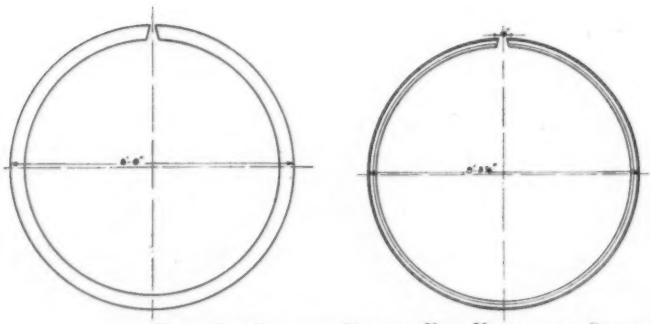


Fig. 15.—Top and Bottom End Views and Section of Barrel as Cast.

Preparation of Loam for Solid Barrels.

For barrels up to 24 in. diameter, which have been termed solid barrels and fluted barrels, the first coating that is applied is called in pipe foundry practice "splash." Its composition and application are as follows:—

Three barrows of common clay to nine barrows of horse manure, milled with water to a sloppy consistency, so that it may be poured thickly from one bucket to another, is applied to the barrels by hand when the barrels are hot, and this is done soon after the barrels are drawn from the pipes. If fresh barrels are used they must be heated up in the stove before splashing, otherwise this material will fall off. When the barrels are heated, this porous "splash" must only be applied a little at a time, not put on in thick handfuls, and if the barrels are not hot enough to dry the "splash" as it is put on, the barrels must be sent into the stove until it is dry. In no circumstances must the cores be finally finished off with ordinary striking loam until the "splash" is quite dry. The cores must also be warm when finished off, and returned without undue delay to the warm stove to stiffen or dry off.

If the above procedure is not strictly followed, trouble will always be experienced with cores that

neither have bands nor loose material put on them. The important factors are these:—(1) The barrel must be hot when splashed; (2) the splash must be dry on the barrel before the core is finished off with ordinary loam; (3) the cores must be warm (not too hot) when being struck up; (4) return to warm stove as soon as struck up.

The reason that trouble will follow if either of the above precautions are ignored is this; in each case it is a matter of controlling moisture and steam generated from the hot barrel. The barrel must be hot to dry the splash while being put on, and when the finishing coating of loam is applied the moisture from it is absorbed by the porous material or "splash"; it then falls away or sags from the barrel, hence the reason for returning the cores to the warm stove to stiffen, or dry, before that can take place.

Preparation and Application of Loam for Spring, Key, and Segment Barrels.

In some respects the procedure in making cores for spring-key barrels is similar to making cores for solid barrels, and in other respects quite different. For the cores now under consideration no "splash" material is required. The first coating is called "clay loam," the composition of which is one barrow of common clay to five barrows of medium strong loam sand, thoroughly milled to a stiff plastic consistency, that can be rubbed on the barrel by the hand with care. As with the solid barrels, this must be applied when the barrel is very warm, just as warm as the bare hand can endure. With the spring-key, or segment type of barrel this first coating need not be dried before the finishing coat of loam is struck up. It is of great advantage when a core can be commenced and finished off in one operation, and with either type of core barrel just named this is possible; but with a hinged barrel it is not practicable to do it in one operation.

The finishing off or striking loam is composed of sand of medium strength, with horse manure and cow hair thoroughly milled to a fine, soft consistency. An approximate proportion would be six barrows of sand, one barrow of manure, and one shovelful of cow hair.

Iron-Boron Alloys.

Boron and iron behave in several respects very much like silicon and iron, and it may therefore be of some interest in this connection to give a few results obtained by Mr. John Härden, who carried out some tests in 1908 with the object of making boron steel.

At first it was thought that calcium boride (CaB_4) would be a suitable starting material, since it is quieter in the electric furnace, and generally easier to handle. Subsequent test showed, however, that this compound has a great tendency to form double carbides, especially in presence of aluminium, forming so-called bor-diamonds. This material is an excellent abrasive, though rather difficult to make regularly; in some cases the author obtained a powder which was quite hard enough to scratch rubies, and even some harder substances might be polished with the product from a melt that has been especially successful, which is not always the case as the treatment requires great care. For boron steel, therefore, electrically-fused boric tri-oxide (B_2O_3) was finally used, with a fairly good result. A stock alloy was first made, in which the boron was determined, and various steels were subsequently made from this. For this purpose, the following charge was tried—2,450 grammes of fused B_2O_3; 2,500 grammes of fine carbon; 2,550 grammes of iron oxide (Fe_2O_3). This was heated in an electric furnace. It was found that the mixture attacked the furnace considerably, a slightly basic lining being used, and that a very high temperature was required. The product when analysed was found to contain:—Carbon, 1.8 per cent.; boron, 15.8 per cent.; silicon, 0.6 per cent. (about); the remainder being iron. The yield was good, and a sufficient being iron.

The next trial had the object of obtaining a still richer stock alloy, and the charge was altered accordingly. The result was a very fine crystalline metallic ingot found to contain as much as 45 per cent. of metallic boron.

The following iron charge was then placed in a magnesite crucible and heated in the electric furnace:—Pig-iron (containing 3.85 per cent. C), 30 grammes; boron compound at 45.00 per cent. B, 33 grammes; wrought iron, 137 grammes. The metal thus obtained showed a remarkably fine structure, absolutely free from blow-holes and pipe, as compared with a similar melt with no boron addition, which showed a much more irregular fracture. The metal contained 7.5 per cent. boron and 1.3 per cent. carbon. This metal was too high in carbon to be called a true steel, and was very hard; it would not forge well.

Another test was then made with 30 grammes of boron compound, and 370 grammes of wrought steel (mild). This gave a much better result. The steel contained about 3.2 per cent. boron, 0.9 per cent. carbon, 0.85 per cent. Si, 0.56 per cent. Mn, and 0.485 per cent. P. Although the phosphorus was so exceptionally high, the metal could be hammered both hot and cool, which is remarkable. A still more interesting fact is that the metal was very mild when annealed, and could be filed and cut almost as easily as an ordinary mild steel of about 0.40–0.50 carbon. Yet, it was capable of tempering and gave a very good cutting edge as a lathe tool. A cut of $\frac{1}{8}$ in. on a rod of 0.35 carbon steel could be taken at a speed by which the chips commenced to show a yellow colour, without appreciably injuring the cutting edge of the tool.

The result seemed exceedingly promising for the compounding of a steel for cutting purposes, even if it did not come up to the grade of a high-speed steel. On the other hand, there is the lower cost of the boron, and the fact that the steel is very easily worked when in an untempered state.

In a further trial, a charge of 37.5 grammes of boron compound and 462.5 grammes of mild-steel punchings was melted and when thoroughly liquid a small quantity of ferro-manganese was added. A pinion wheel was cast in a dry-sand mould. The cast came out very clean and smooth, with no blow-holes, the edges and the teeth being remarkably sharp. The wheel proved to have excellent wearing qualities.

As a result of these tests, it seems safe to say that boron has a great capacity for cleaning molten steel from impurities, especially oxides; this is shown by the fact that although the phosphorus was in one instance as much as 0.48 per cent., which would have rendered it impossible to hammer the metal cold under ordinary conditions, yet when the boron was added it forged perfectly well. This would indicate that the dreaded and obnoxious element, phosphorus, is not so dangerous *per se*, but that the different oxides and sub-oxides which are so readily formed in the presence of oxygen-giving substances act as an intervening layer of "mud" between the iron molecules, and thus lower the coherence of the metal. If the oxygen is removed by a stronger agent, it is possible that the phosphorus simply alloys with the steel and does less harm.

Malleable Castings.*

By W. H. Hatfield, D.Sc.†

Malleable cast iron has been properly described as "iron which when first made is cast in the condition of cast iron, and is made malleable by subsequent treatment without fusing. Although the English name of the variety suggests that it is cast iron, it is not truly a variety of cast iron, because it lacks the essential property of that material, the 'extreme brittleness.'" This definition, however, does not really satisfactorily deal with malleable cast iron. In the first place, to say that it merely lacks the extreme brittleness of cast iron does not do it justice, and when the definition says it lacks the essential properties of cast iron that hardly confesses the truth, because it is cast iron, and must be treated as a cast iron, having all the advantages, which are many, of such material, without the disadvantages. Cast iron has a very low fusion point. It, however, contains much silicon and, indeed, the whole of the chemical composition is such as to result in the possibility of the smallest castings being cast without the possibility of such unfortunate occurrences as blow-holes, etc., and it therefore follows that when castings of such material can be rendered ductile and malleable by annealing, a material is obtained which is of considerable value in the mechanical arts. Suitably annealed malleable cast iron does more than lack the "extreme brittleness" of cast iron. [The lecturer here illustrated the results to be obtained from the standard test bars of various types, and it was shown that with the Admiralty section 180 deg. bending angle might be obtained, whilst with 1 in. square section as much as 90 deg. could be obtained.]

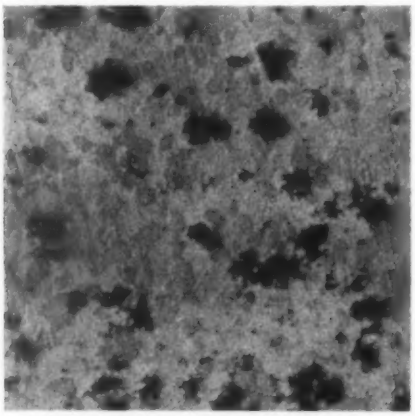


FIG. 1.—"BLACK-HEART" MALLEABLE.

There are now available for the production of small articles three definite types of material; first, the wrought-iron or steel forging, second, the malleable casting; third, the small steel casting. Fig. 1 shows the micro-structure of a well-annealed malleable cast iron of the "black-heart" variety. It will be seen that it consists of ferrite—as a matter of fact, of silico-ferrite—through which is distributed the whole of the carbon content as nodules of free annealing carbon. A wrought-iron forging if examined presents much the same structure; the ground mass is again ferrite, but in place of the tree-carbon nodules is found the slag. If the micro-structure of the small steel casting be now considered, several essential differences will be apparent. Neither free carbon nor slag are present except, of course, the minute sulphide inclusions which are present as a result of the chemical reactions taking place in the material; the matrix again is ferrite, but there is a new constituent, pearlite, occupying a considerable portion of the section. [The lecturer here put on to the screen an example of pearlite magnified 1,500 diams. clearly showing the beautiful laminated duplex structure of this constituent, and then followed with slides indicating the advisability of suitably annealing small steel castings. This was particularly emphasised by one slide showing the well-developed Witmanstatten structure, followed by another slide showing how such structures may be removed by careful treatment.]

The equilibrium diagram of the iron-carbide system (Fig. 7), is very useful in studying the technical points arising in the treatment of iron and steel generally. It should form the basis of any discussion of the phenomena associated with these alloys. It must be emphasised that the diagram presented strictly refers to the purely binary system, iron and iron-carbide, and that if, as is invariably the case in commercial alloys, any other element is introduced, the lines of the diagram require modifying to a greater or less degree.

The addition of carbon to pure iron gradually lowers the freezing point from just above 1,500 deg. C., which is the melting point of wrought iron at the point A, down to 1,130 deg. C. at the point B. The point B indicates the alloy which has the minimum freezing point, and which is the eutectic alloy of iron and carbide (pig-iron always approximates to the eutectic in carbon content), and the utility and success of cast and malleable cast irons are undoubtedly due to the low freezing point of this alloy.

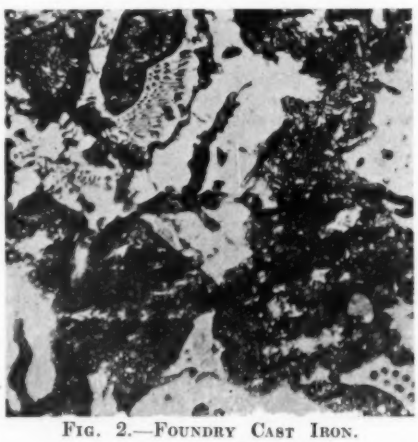


FIG. 2.—FOUNDRY CAST IRON.

* Abstract of Lecture at the Birmingham Branch of the British Foundrymen's Association, March 13, 1915, Mr C. Heggie in the chair.

† Technical Director, J. Crowley & Co., Ltd., Sheffield.

In the blast furnace the ore is reduced to spongy iron in the upper regions, and as the metal descends the carbon is absorbed from the coke; the conditions prevailing in the furnace are such that the molten material invariably becomes a saturated solution of this and other elements. As this bath of iron, saturated with carbon (as carbide), cools down to the freezing range, the excess carbon is thrown out of solution as carbide, which simultaneously dissociates into iron and carbon with the production of kish.

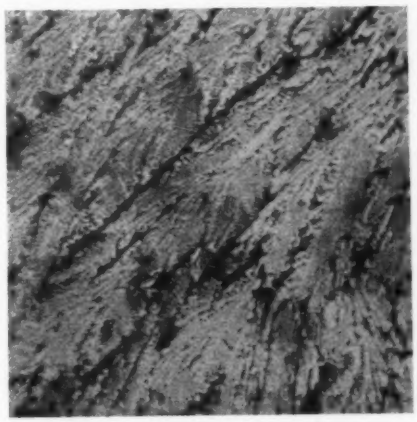


FIG. 3.—SWEDISH WHITE IRON.

If we consider a purely iron and iron-carbon alloy of eutectic composition corresponding to the point B in the diagram, during freezing we shall find that the eutectic alloy breaks down at B into the eutectic mixture, which consists of the two constituents, carbide of iron and solid solution. This solid solution is very rich in carbide of iron, and as it cools down the surplus carbide is thrown out of solution, thus adding to the amount of cementite carbide found in the material. By the time the recalescence point is reached in the neighbourhood of 700 deg. C., point J in the diagram, the mass consists of carbide of iron in a matrix of solid solution. During the recalescence, however, this solid solution breaks down, the iron throwing out the remaining carbide, with the resulting formation of pearlite which, as has been pointed out, is a mixture of ferrite and carbide.

In Fig. 3 will be seen the structure of an alloy closely corresponding to the eutectic, *i.e.*, Swedish white iron. Whilst discussing the diagram it might be pointed out that the presence of the silicon, phosphorus, etc., present in foundry irons fundamentally modifies the position of the lines of the diagram. For instance, the influence of silicon is to remove the eutectic point B along the line D, B, in the direction of D, and at the same time to move the line to a higher level in the diagram. When phosphorus is present a tenary eutectic of iron, phosphide and carbide is produced, which results in the position of the eutectic point being much lower in the diagram. It will thus be appreciated that in an ordinary foundry iron containing 2.5 per cent. silicon, 1 per cent. phosphorus, and a fair proportion of manganese, not forgetting an appreciable sulphur content, the most complex structure will be obtained.

In Fig. 2 is given the micro-structure of such an ordinary foundry cast iron. The predominating feature will be seen to be the plates of graphite which are responsible for producing the brittleness of cast iron. Now, in a malleable casting there should be no graphite, and therein lies essential differences between cast iron and malleable cast iron. In cast iron the phosphide, *i.e.*, the white eutectic structure, will amount to as much as or more than 1.0 per cent. This phosphide is very hard and brittle, and further conduces towards brittleness. In a malleable cast iron in this country not more than 0.05 or 0.06 per cent. of phosphorus is present, and it all remains in solution; it should, however, be remembered that in America the phosphorus runs up in malleable cast iron to 0.2 per cent. As a matter of fact, I see no reason why it should not, without any detriment to the final properties of the casting. If reference is made to Fig. 2, the dark patches of pearlite will be noticed, which are a strengthening feature in cast iron.

There are two distinct types of malleableising; the old European method known as the Reaumur, and the American "black-heart" process. The old European process has been in operation over 200 years, and has, indeed, been carried on in Birmingham for something like 150 years.

In Fig. 5 is shown the micro-structure of well-softened European malleable cast iron. It will be seen to be very similar indeed in essentials to the 'black-heart" variety, except that pearlite is found scattered in the matrix. In the European process the white pig-iron is melted and cast, and then annealed. The old idea of the process being that it was one of decarburisation, the annealing was so arranged that the carbon should be removed. As cast, the casting has a structure as represented in Fig. 4. Essentially the constituents are the same as in the Swedish white iron indicated in Fig. 3. After melting, however, the casting has not a sufficient carbon content to be considered any longer as exactly eutectic. It may, however, be considered as an eutectic slightly diluted. During heat treatment the oxide of iron is responsible for the elimination of the carbon from the exterior of the casting, and this action increases in intensity with rising temperature. The essential point, however, is that the temperature should be attained at which the remaining free carbide of iron becomes unstable. This temperature is,

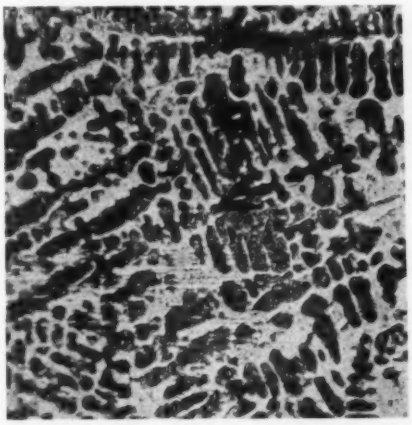


FIG. 4.—HARD WHITE IRON FOR MALLEABLEISING.

of course, dependent upon the composition of the iron and, unfortunately, where a founder does not know the composition he cannot control economically this annealing temperature. It is necessary to attain in this process temperatures at which the carbide is unstable before complete softening of the iron can be obtained. If such temperatures are

not attained the result is that when the castings reach the machine shop they are found to be very hard. Fig. 6 indicates the micro-structure of such a hard casting, and it will be seen that the cementite carbide is still largely in existence.

[The lecturer then proceeded by a series of lantern slides to illustrate the decomposition of carbide under varying conditions, indicating the influence of composition and sizes of original structure. He discussed

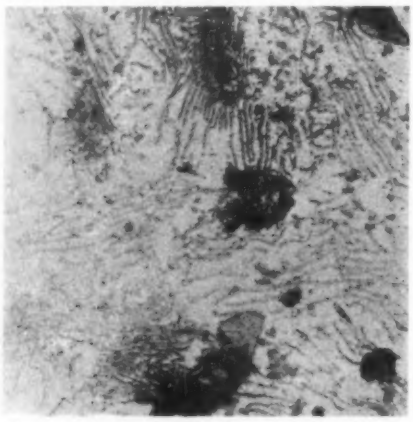


Fig. 5.—European Malleable Cast Iron.

at some length the American method of producing malleable cast iron, and gave some account of the principles underlying the method. The American or "black-heart" process consists essentially of the breaking down of the carbide and, owing to the sulphur being balanced by sufficient manganese, the whole of the pearlite carbide, as well as the cementite carbide, becomes decomposed during the heat treatment.]

Discussion.

Professor Turner said that mention had been made of the fact that the Americans were doing a great deal in connection with malleable cast iron. That was due in part to the fact that the Americans had a special kind of iron for such purposes, a charcoal iron which was very suitable for that kind of work. At present in that country it was usual to equip a large works with a Siemens or other large furnace to get the proper composition of iron for malleable castings. We used the Siemens furnace in some cases also, but our trade in malleable castings was not more than one-tenth of that of the United States, though the material was one that was wanted for a large number of purposes. In the malleable cast-iron trade, a few crucibles and patterns and a shop costing less than the earnings of one year had in the past enabled a man to do well. That time was rapidly passing and would soon be gone altogether, and he believed it would be for the benefit of the trade as a whole when the work could be done in a large factory in which the pyrometer and the microscope were used, and which had a chemical laboratory. It did not pay to do scientific work where an industry was carried on in a number of small and imperfectly equipped establishments.

Mr. F. C. A. H. Lantsberry asked whether it was necessary to have for the production of ordinary Reaumur malleable castings iron of a different composition from that used for the production of black-heart. Could a black-heart casting of high quality be got from the same composition as was used for the ordinary Reaumur malleable castings? Dr. Hatfield had said that when pearlite was heated above a certain temperature the cementite of the ferrite fused into solid solution. He (Mr. Lantsberry) had always thought the Sheffield doctrine to be that these substances fused into a compound known as Hardenite.

Mr. F. Johnson said that he would like further information on the mechanism whereby the annealing carbon was produced. Dr. Hatfield had indicated that that annealing carbon was the result of the breaking-down of carbide of iron, that the free carbide of iron existing in the eutectic was the material that gave, *ab initio*, the annealing carbon. Might it not be that the annealing carbon came from the austenite solid solution, and that this having precipitated from itself some of the dissolved carbon, the conditions of annealing favoured the absorption of more carbide of iron, so that a continuous process was got, the deposition of carbon from the solid solution and the reinforcement of that solid solution by carbide from the eutectic. He thought there was some evidence, in the micrographs shown, pointing towards deposition from the solid solution. There was apparent carbon, pearlite, and free cementite; the free carbon existed in the pearlite areas, and there was visible no evidence of the change taking place, no transition of the free carbide into iron and carbon. Another interesting point was that in annealing the white iron a ductile variety of iron was got; but one might think that the conditions of annealing were ideal arrangements for cementation. That, of course, was a remark which one would make after only a cursory examination of the facts; there were other materials present, notably, silicon, which prevented re-cementation. He would like to ask Dr. Hatfield whether he could tell them whether the purest white iron obtainable could be broken down into iron and carbon. If that were so it would tend to throw light on the mechanism of the cementation process, and might give further evidence that the

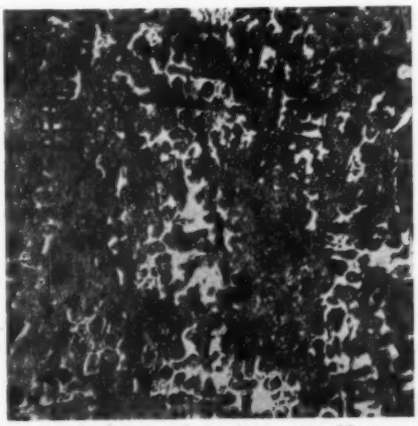


Fig. 6.—Insufficiently Annealed Malleable Casting.

cementation process was entirely dependent upon the action of gases.

Mr. J. Matthews said he was very much against the use of chills to prevent shrink holes in malleable castings. They certainly were useful in some cases, but the use of feeders was a much better method. He would like Dr. Hatfield to state the tensile strength of the samples shown in the two photographs on the screen, one with the high and the other with

the low percentage of manganese. With Professor Turner, he felt that the scientific methods of production of malleable castings needed to be studied more in the foundry. Of course, there were many foundries that did produce good castings, but he was surprised how few took any notice of the temperature at which the metal was poured; yet that made a lot of difference. He would say with reference to the castings mentioned by Dr. Hatfield, that one of the specimens shown would come out a great deal stronger for being cooled quickly than the one which was cooled slowly and showed the blotches of free carbon. He mentioned an experiment he made with a particular brand of iron. He had two castings made of a round bar, one $\frac{1}{2}$ in. diameter and one 1 in. diameter. The smaller one came out very good after being annealed, but the larger one showed specks of carbon, was soft, but rotten. He then had cast two bars of 1 in. diameter with the same metal, but with a small amount of ferro-manganese added in one case. The result was surprising. The manganese improved the metal; for while the bar without the manganese broke at the first blow when

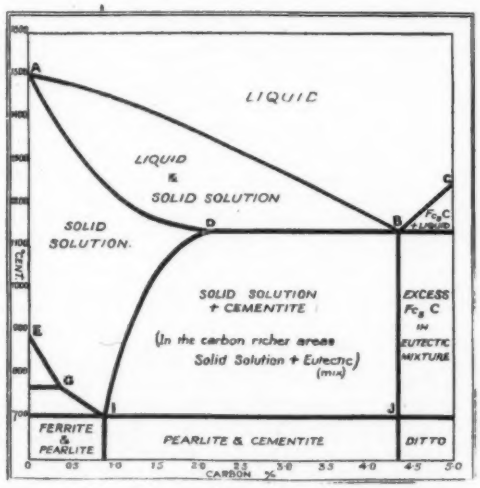


FIG. 7.—IRON-CARBIDE DIAGRAM, SHOWING PHASES IN EQUILIBRIUM.

struck across the anvil, seven blows were required to break the one in which the manganese was present.

MR. R. BUCHANAN supposed that when Dr. Hatfield mentioned the use of Swedish iron in making malleable castings, the use of it in Reaumur castings was referred to. He remembered a Swede who some years ago had come over to buy English pig-iron for black-heart work, as it was more readily treated for that process than the Swedish could be. There was also probably a question of price. Could Dr. Hatfield give them some indication as to the relative merits and difficulties of casting with the two processes. As far as the speaker was aware, the Reaumur process was not in use in America. He knew that the black-heart process had invaded England, and was being put to considerable use here. Therefore it was to be presumed that the black-heart process had some merits which the Reaumur had not.

MR. W. B. PARKER remarked that in nearly every book or lecture relating to malleable-iron castings they were told that the final material was a mixture of ferrite and graphite, with traces of carbide, but they heard of no attempt to improve the character of the ferrite. They knew that certain elements very much modified and improved the physical properties of the ferrite itself. For instance, when they got up to 3 or 4 per cent. of silicon the electrical properties of the iron were greatly improved by the magnetic permeability being increased and the hysteresis losses decreased. If nickel were added the ductility was greatly increased, and so forth. But among the publications on malleable iron were to be found no results of experiments to increase the value of the main product, namely, the ferrite. Graphite was a nuisance in such a casting, and he was perfectly sure that ultimately they would be able to get rid of it. Therefore, he would like to know whether any experiments had been made to produce a reliable malleable iron of this character. He believed that manganese retarded the rate of malleablisation, and, no doubt, the question of cost was one of the reasons why they did not hear much about it. He thought that one explanation of why the black-heart malleable cast-iron industry was growing in England was that it was cheap, cheaper in regard to raw material, and he believed, considerably quicker in manufacture. He exhibited some small castings ready threaded for gas- and water-pipe plugs which had been made in America and delivered carriage paid in England at 3s. 4d. per hundred, which worked out about 6d. per pound.

MR. F. J. COOK desired some information on the lines indicated by Mr. Buchanan, namely, as to the relative values of the two processes. As a user of heavy malleable-iron castings, he thought it possible that the one process might give superiority in transverse tests, and the other in tensile strength. As to the use of chills, the lecturer had remarked that if one had a chill where otherwise there would have been a hole, that was simply moving the defect, or, perhaps, splitting it up into smaller parts. But in dealing with grey cast iron that was not correct. He had been using chills in casting for very many years. As to the question of a feeder, if one could chill the casting gradually from the bottom to the top, the casting would be solid all through. With a chill in grey iron the portion near the chill cooled more quickly than did the other portions: therefore, the more liquid packed up to the part that had been chilled, and thus the difficulty was removed. He knew, of course, that the rate of cooling was very much more rapid with malleable cast iron than with grey iron, but difficulties could be removed in all directions by the judicious use of chills. They were also to be recommended from a point of economy as the use of chills could be made to take the place of hand feeding and thus save time and expense.

DR. HATFIELD, replying to the discussion, referred to Professor Turner's remarks. They all looked very kindly on the small manufacturer, for industry commenced with the small manufacturer. But he was afraid that the malleable cast-iron industry was of all industries the one which it was a great advantage to carry out on a considerable scale. If the materials could not be analysed, they could not have that consistency of composition which was necessary, and the absence of which had hitherto prevented the advance of the malleable casting. He quite agreed that the tendency of the industry was towards centralisation. With regard to Mr. Lantsberry's remarks, as to the possibility of Reaumur and black-heart castings being made from the same iron, the answer was that it could not be done, or, to speak more correctly, a Reaumur and a black-heart could be made from the same iron, but only by modifying the composition, which meant practically that the same iron was not used. They might take the iron used in producing a Reaumur casting and obtain the

steely fracture. If manganese were added to that iron the sulphur would be neutralised. The manganese took no part in the reaction resulting in the free carbon, but still it would eliminate the influence of the sulphur and precipitate the carbon, with the result that a black-heart casting would be obtained from the white iron. He had produced black-heart castings containing as much as 0.45 to 0.50 per cent. of sulphur. Mr. Johnson had gone straight to the centre of the theoretical controversy. The theory favoured by Mr. Johnson ruled for a great number of years, but it was ended after much dispute on the lines he (Dr. Hatfield) indicated, so that he (Mr. Johnson) was really reverting to a view held before the data was obtained which settled the controversy. The carbide must appear first. Both from the practical standpoint and the theoretical standpoint, he was convinced that what he had told them was correct, namely, that the iron-carbon equilibrium diagram should be considered as dealing with the iron-carbide system, and that if no other elements intervened they had only the iron and carbide to deal with. Mr. Johnson had asked whether the pure white iron could be broken down. It could be probably broken down. He had not time to go into the subject then, but if Mr. Johnson thought the matter of sufficient importance he would be glad to communicate with him upon it. He was very much interested in Mr. Matthew's comments and the question as to the effect of manganese upon the strength of the iron. The matter was one of works practice, and the manganese was only useful so far as it controlled the condition of the carbon. Referring to Mr. Buchanan's question as to the respective merits of black-heart and Reaumur, he could only say that both Reaumur and black-heart castings were manufactured because each had its respective merits. The black-heart was more easily machinable and the Reaumur was harder, and not so easily machinable. Of course, the latter, apart from all other virtues that it might possess, had a fracture like steel. He thought there was very little difference in the respective merits of these materials when all was summed up, but one got more ductility in the black-heart and easier machining. Something had been said about the black-heart being cheaper; of course, if they were comparing black-heart made on a large scale with a Reaumur casting made in a crucible on a small scale, no doubt the former must be cheaper, but where Reaumur was made on a large scale the difference in the price might disappear. A very vital point was touched upon by Mr. Parker when he discussed the properties of the ferrite. That was the crux of the whole question. Some years ago he thought that just as a special element might be added to steel to modify its nature so the same might be done with malleable cast iron. He had tried chromium, nickel, manganese, vanadium and sulphur, and other elements in varying proportions, but he was afraid that there was not very much scope in that direction. Chromium and vanadium went into the carbide and rendered it so stable that it could not be decomposed. Nickel led to precipitation of carbon similarly in action to silicon. It prevented one obtaining a white iron except with great care. Still that was a very important aspect of the question of malleable castings, and he might say that the result of the study he had given to the subject and of experiments in their own works had been that they had obtained elongations as high as 18 and 19 per cent. from the ferrite matrix. That was a great advance upon the elongations of 2 or 3 per cent. The yield point was 12 to 14 tons. (Mr. Parker: Somewhere about 8 tons is the true proportion.) Well, it was higher than some of them would think. The castings to all intents and purposes was wrought iron. No doubt Mr. Parker would be interested to know that they had been making some experiments as to the permeability of castings and that they had been able by modifying the ferrite to modify greatly the permeability. He was very much interested in Mr. Cook's remarks, and particularly in what he had to say about chills. He knew that in America it was practically all chills, but he could not but agree with Mr. Cook that chills with runners could be used with very good results. The point was that unfortunately a chill was generally used where a feeder should be used.

ELECTRIC FURNACES.—Before the Birmingham Association of Mechanical Engineers and the Birmingham Branch of the British Foundrymen's Association, on March 27, a lecture was given on "Electric Furnaces" by Mr. J. H. Stansbie, B.Sc., F.I.C. The lecturer first gave a general survey of the development of electrical furnaces since 1878, and continuing, remarked that there was no doubt a very great future in store for improvement in the conversion of the latent energy of coal into electrical energy. The outstanding feature of electrical energy was its power of concentration. While the temperature obtained by the combustion of carbonaceous fuel or of hydrogen under the most favourable conditions would not exceed 2,000 deg. C., that of the electric arc was at least 3,500 deg. C. Mr. Stansbie proceeded to describe various furnaces, including the arc furnace, the Stassano furnace and resistance furnaces. The Kjellin furnace was mentioned as one of the most successful of the early forms, while the Röchling-Rodenhauser was considered the most successful of the induction type. As it was found that a tilting furnace was more workable than a stationary one, all the recent furnaces were of the tilting type. An important feature was the fact that the passage of the current through the molten metal set up a kind of rolling motion by which the metal bath was thoroughly mixed. The electro-Bessemer combination furnace was a successful attempt to reduce the cost of the electric energy required for refining, by making use of the oxidising action of an air blast for the preliminary stage. After showing the value of arc resistance for purely chemical work, as illustrated in the manufacture of calcium carbide, the speaker referred to the furnace of Messrs. Grönwall, Lindblad & Stalhane, Sweden, as the latest and most successful furnace for iron-ore smelting. One feature of this furnace was the arrangement for forcing the gas leaving the top of the shaft back into the hearth space in which the electrodes were situated. This modified the high temperature in the neighbourhood of the arcs and so increased the life of the lining as to make the furnace a success. The reduction of the ore was effected by coke, and only one-third of that used in ordinary blast-furnace practice was required. At the conclusion of the lecture Mr. Stansbie gave a series of demonstrations of electrical melting in simply-constructed furnaces, steel and other metals being successfully and quickly melted.

The Daimler Company, Limited, of Coventry, are installing an electric steel furnace which is being supplied by the Snyder Electric Furnace Company, of Chicago. The furnace will have a daily capacity of four tons, and will be operated on a refining basis melting cold material. The castings from the furnace will be used for aeroplane engines, automobile engines, etc. Mr. G. J. Stock, formerly of the Stock Oil-fired Converter Company, is now the British representative of the Snyder Company, having disposed of his interest in the former company. Mr. Stock's headquarters are at The Villas, Middleton St. George, Darlington.

Core-Boxes and Core-Making.

By D. Gordon, A.M.I.Mar.E.

(*Continued from page* 143.)

Cores of a curved or bent conformity such as would be required for bend-pipes or work of a like nature, are invariably made up in one of three ways; (1) By means of a core-box; (2) with guide and strickle; or (3) by layering or thicknessing the mould to the required core size. A core-box is adopted when the work involved is of such a nature that it is more economical or advantageous (it may be even necessary) in the core's production. In this matter, shape and size are the chief considerations, as a core of irregular form and varying section may be either impossible, or economically prohibitive by any other method, even when the number required is small. Further, if the sectional area is small, the core's production is beyond the scope of either the strickling or layering methods, as these methods are confined within the limits of convenience and adaptability.

When cores are required in large numbers or are of a standard or repetition order, the utility of a box is beyond question, as by its means greater rapidity of production can be obtained.

The guide-and-strickle method for producing cores of this type is adopted when the number required is small and rapidity of output is necessary, and the time that would be necessary in producing a core-box is not available. This method is limited and confined in its applicability to work of sectional

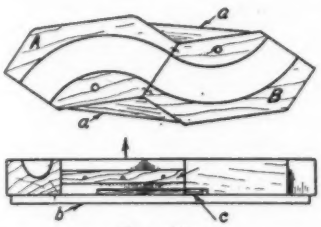


Fig. 70.

Fig. 72.

uniformity and where the centres are contained within or upon one plane. Its efficiency for cores of the "one-off" variety is beyond doubt, but when adopted for producing large numbers it is economically a failure, when interdepartmental costs between foundry and pattern-shop are considered.

The method of layering or thicknessing up of a mould to produce its own core is only adopted when the number required is small and irregularity of shape involves unwarranted cost in producing a box, and where also the core is beyond the scope of the guide and strickle.

In making core-boxes for bent cores, mechanical means for rapidity of production are as far as possible utilised, and in this respect various machines which are on the market more or less efficiently fulfil the necessary conditions, but as their cost prohibits their general adoption as part of a pattern-shop's equipment, or their constant employment is not always possible, only the more general and common mechanical means, *i.e.*, the lathe, is here considered. Nevertheless, the greater efficiency of some of the mechanical "woodworkers" is not belittled; for the class of work under consideration they are in most respects superior to the lathe, being in no sense confined to truly circular work as is the case when the lathe is used.

The chief consideration in making up boxes, or parts thereof, by means of the lathe is eliminating as far as possible waste of material. Conditions necessitate for some types of boxes, a certain amount of waste, which is unavoidable, unless undue risks are taken. As this class of work is confined to face-plate practice, two examples (Figs. 70 and 73) of boxes thus made are given; but as the practices involved are, in detail, open to many modifications,

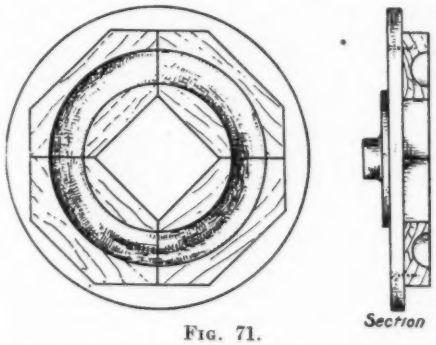


Fig. 71.

it is not to be assumed that they are in any sense arbitrary; they are rather cited to indicate common practice, the principles of which are constant and unchangeable.

Fig. 70 shows an S-pipe half-core box made up entirely by means of the lathe. The box portions *A*, *B*, are relatively the same for the other half box and the complete box is thus constructionally formed of four segments. These segments are assembled upon the face plate, after being trued up to thick-

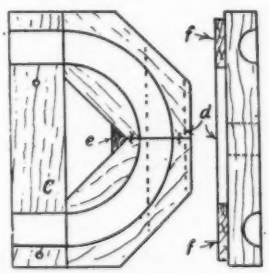


Fig. 73.

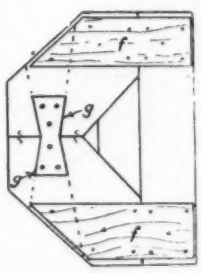


Fig. 74.

ness, and turned to the required section; either by means of a template or a right-angled set square. When the work is sectionally circular, as the example, a template is invariably dispensed with, the set square being equally efficient, and as its adoption is frequently required for all classes of circular section work, the square at its bearing angle is metal-tipped (X, Fig. 72) to lessen the wear due to its use in indicating the untrue parts. When turned

to section the parts *A*, *B*, Fig. 70, are butted together as shown and cleated at the joint position. Strengthening brackets *a—a* are glued and screwed into position, their object being to prevent any lateral movement of this joint. Bearing battens *b* are firmly attached to both portions, and may be full or only part-cover battens, as found most convenient and strong. The surfaces of the battens coming into contact with the box parts essentially must be true and in perfect alignment, any winding of the material having a corresponding effect upon the box joint proper.

Another method frequently adopted to further ensure the box joint remaining true is to insert a batten *c* into both parts, this batten being of a

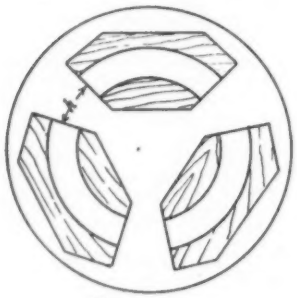


Fig. 75.

Fig. 76.

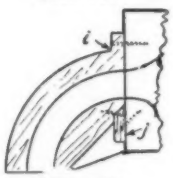


Fig. 77.

harder material than that of which the box is built. Very frequently a metal plate is utilised for this purpose.

In the *U* box, Fig. 73, the turned portions are retained in position by means of a batten *d*, lateral support being given by the corner block *e*. The box portion *C* is held in position with the other two parts by means of cross battens *f—f*, as shown in the inverted view Fig. 74. This figure also shows

Fig. 78.

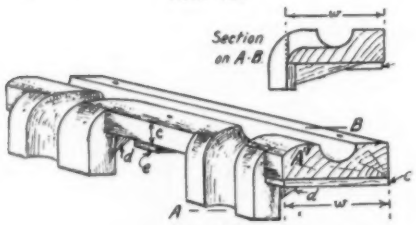


Fig. 79.

another attaching method, viz., by means of a dovetail tie *g—g* let into both parts, either the full length as indicated by the dotted lines, or only a part distance. The angles of the tie should not be too acute but sufficient to have a drawing or pinch-dog action, and to fulfil requirements satisfactorily must essentially be well and tightly fitted.

In the two foregoing examples the material turned upon the lathe has been fully utilised, but if it be assumed that a $\frac{1}{4}$, $\frac{1}{8}$, or $\frac{1}{2}$ bend only is required, the use of four segments to attain this end would give a considerable amount of unnecessary product. For this reason, and to reduce this usually waste material, the required box parts are assembled upon the face plate in such a manner that centrifugal balance is obtained during the turning operation. When the spaces between the two portions are not excessive, and the lathe can be run at a high speed, the risk involved owing to the tool catching or lathe jarring is a matter of little consideration, but if at all excessive the danger is proportionately greater; therefore to lessen this risk another portion is inserted, the distance apart *h*, Fig. 75, thus being lessened to a negligible quantity.

If the material required for forming a box part is sectionally greater than can be conveniently made from one piece, the work is then laminated or built up as in Fig. 76. The layers, or courses, in shape and size are cut according to their requirements, consideration in every case being given to economy consistent with durability, it being well to bear in mind that every course upon its joints must be firmly and *permanently* united so that the rising of the material at these positions is completely obviated.

Fig. 77 shows one common method of fixing a portion of a box which has been turned, and is therefore of a segmental shape. This is cut back as at *i* after the turning operations, to receive and carry the binding screws which enter the box part with which it is in contact. When the set-back cannot conveniently be made upon both sides, a carry block *j* is let into and firmly fixed, as one portion of the unit to be attached, its projection beyond the edge being sufficient to allow of screws entering through it.

When the centre lines of a core are not on the same

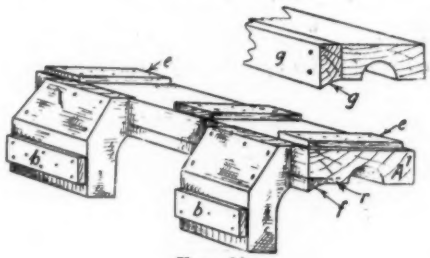


Fig. 80.

plane, as in the case of a double bend or twist pipe, the majority of the core-boxes required are jointed upon their surfaces to follow out the most convenient centre line, every facility being given for the easy relief of the core. In some cases it is preferable to have the branch portions to work off the main body as loose pieces. In such cases much, of course, depends upon the core size and the handling operations previous to drying, especially if the core requires a sand bed for this purpose.

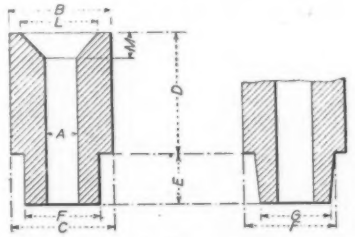
An example of a core, the joint or centre line of which is not contained within one plane, is that for the common type of induction pipe. In Fig. 78 the core for one of these pipes is shown. It will be clear that its removal from a box necessitates the box being jointed in such a manner that its withdrawal can easily be obtained by parting at the various centre lines. This can be done without any twisting movement, but in some cases the centre is of necessity of such a nature that "screwing" or twisting is imperative. The box required for producing such a core is constructed as shown in Figs. 79 and 80, the joint following out the centre line of the straight body and the curvature of the branches. The main portion of the box A^1, Figs. 79 and 80, contains also parts of the branches; but the amount must be governed by the question of convenience in handling, combined with strength, as the greater the branch

amount formed from this body, the greater is the curvature resulting, which may tend to produce weakness owing to the reduction of the material at *c*. The branch portions are preferably housed into the main body, the amount rebated being sufficient to ensure their position and prevent any lateral movement. They are glued and screwed into position and further strengthened by means of the stays *d*, *d*, which are screwed to them and also to the main body part.

Referring again to the main body portions, battens *e*, *e*, are placed at various positions to counteract any warping or shrinking, the number of battens depending upon the thickness of the material and its liability to these defects.

The box half, Fig. 80, is made up in a similar manner to Fig. 79, save that the main body surface joint is formed from two pieces, one of which contains the flat surface only and the other the required curvature which abuts against the other half at the branch positions, and, of course, the continuity in the full length. By utilising two pieces greater economy of labour and material is effected. Fig. 80 gives two methods for obtaining this joint, *f* being by means of rebating an amount sufficient to contain the required curve, the rebate at *r* being full enough to obtain strong screw holds when glueing it into position. In the other method, *g* abuts against the box side.

In some cases it may conceivably be advantageous to have the battens *e*, *e*, sufficiently wide to embrace the branch portions, and further introduce corner blocks at those positions contiguous to the main body. The battens *b*, *b*, would be fixed crosswise to the grain of the material forming the branches, and here again upon their number would depend their size.

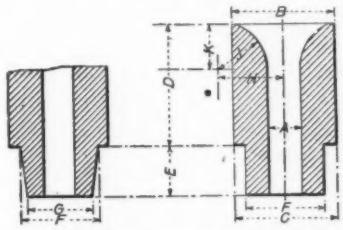


Name of Foundry	Dimensions in Inches								
	A	B	C	D	E	F	G	L	M
Wellman Seaver Morgan	2	5¼	5	3	1	4	4	4¼	⅛
Union Steel	2½	5⅜	4⅞	4½	1½	3⅝	3⅝	4⅜	⅜
National Malleable	2⅜	6	5⅜	5¼	1⅜	4⅜	3⅜	5¼	1½
" "		5⅜	4⅝	3½	1½	3	2½	5⅜	1½
" "		5⅜	5	4¼	1½	3½	3⅛	5⅜	1½
American Bridge	3	5½	5⅜	5⅜	1½	4	4	4½	1
" "	2	5¼	5⅜	6⅛	1⅜	4	3	4½	1½
Columbia Steel	2	5⅜	5½	5	1⅜	4⅜	4⅜	4½	½
Hubbard Steel	2½	6	5⅜	6⅜	3	4⅜	4⅜	4⅜	⅜
Seaboard Steel	2⅜	5¼	5⅜	4⅜	2	3½	3⅜	3¼	⅜
Wheeling Mold	3	5⅜	5⅜	7	2⅜	4½	4½	5⅜	1½
Boldt Steel		6	6	4	2	5	5	4	⅜
" "		6	6	4⅜	2	4½	4½	3⅜	⅜
Allegheny Steel	2	6	6	7	4	4½	4½	4½	1½
Detroit Steel	1⅜	5⅜	5⅜	6⅜	2	3½	3½	4⅜	1⅛
National Foundry	2	5½	5½	4⅜	3	3½	3½	4½	1
Ohio Steel	1½	5⅜	5⅜	7	1⅜	4½	4½	4⅜	
" "	3	5⅜	5⅜	7	1⅜	4½	4½	5	
Penn Steel Castings	2	4⅜	4⅜	3⅜	2⅜	3⅜	3⅜	2⅜	⅜
" " "	2½	6⅛	6⅛	4⅜	2	4⅜	4⅜	3½	2½
Penn Steel	2½	7	7	4	1⅜	4⅜	4⅜	6	⅜
St Louis Steel	1½	5⅜	5⅜	4⅜	1½	4⅜	2⅜	4⅜	1½
"Strong Steel	1⅜	5⅜	5⅜	4½	2⅜	3½	3	4½	1⅜
American Steel Foundries	2	5⅜	4⅜	7	1⅜	3⅜	3⅜	4⅜	1⅜
Bettendorf Co.	1⅜	5⅜	5⅜	6⅜	2½	3½	3⅜	4½	1⅜
Average	2⅛	5⅜	5⅜	5½	2	4	3⅜	4⅜	1⅜

SIZES OF TWO FORMS OF NOZZLES USED BY AMERICAN STEEL FOUNDRIES.

Nozzle Brick for Steel Foundry Ladles.

Five standard nozzles have been proposed for use in steel foundries by a committee of the American Foundrymen's Association. In fixing the standard the committee got in touch with 42 of the principal American steel foundries. There appears to be an equal division of opinion in regard to the relative desirability of the round-face and straight-face nozzle. This being the case, the committee recommend that two general designs of nozzle be decided on as the Association standard, one having the round face and the other the straight face. The standardisation is of interest to steel foundrymen only. Because a particular product gives satisfaction in rolling-mill ingot practice, it is no criterion of its usefulness in the steel foundry, where the most severe service is encountered. Attached to the report of the Committee are results of the canvass of all the principal American steel foundries. These are of more interest in this country than the standards proposed, which vary little from the particulars furnished by the foundries and included in the appended tables.



Name of Foundry	Dimensions in Inches									
	A	B	C	D	E	F	G	H	J	K
Birdsboro Steel	2½	5⅛	5⅛	4⅜	2½	4½	4⅛	2½	1⅛	1⅛
" "	3	5⅛	5⅛	4⅜	2½	4½	4⅛	2⅜	1½	1⅛
Bucyrus Steel	2	7	6½	4	1⅛	4⅛	4	3	2	2
Cleveland Steel	2	6⅛	5⅜	2	1⅛	4⅛	4⅛	3½	2⅜	2⅛
Chester Steel	2	5⅜	4⅜	4⅛	1⅛	4	3½	2½	1½	1½
General Electric	2	5½	4⅛	4	1½	3⅜	3½	3⅜	2⅛	2⅛
" "	2	5½	5	4	1½	3⅜	3½	3⅜	2½	2⅛
Monarch Steel	1⅛	5½	4⅛	5	1½	3½	3½	3	2½	2⅛
A.J. Haws and Sons	2	4⅛	4½	4	1½	3⅛	2½	1⅛	1⅛	1⅛
Duquesne Steel	1⅛	5	5	4	2½	3⅛	3½	3⅜	3⅜	3½
Jones and Laughlin	1½	5⅛	5⅛	8½	1½	4⅛	4⅛	2½	2	2⅛
" " "	2½	5⅛	5⅛	6⅛	1½	4⅛	4⅛	2½	2	2⅛
Lawrence Steel	1⅛	4⅛	4⅛	4	1½	3½	3	3⅛	2½	2½
McConway & Torley	2	4⅛	4⅛	7	1½	3⅛	2⅛	3⅛	2	1⅛
Mesta Machine	2½	5⅛	5½	5⅛	1⅛	4½	4½	2	3	3
" "	3½	6⅛	6⅛	5½	1½	4⅛	4⅛	2½	3	3
Fort Pitt Foundry	3	5½	5½	5	1⅛	4½	4⅛	2½	1	1⅛
Commonwealth Steel	2½	5⅛	5⅛	6½	1½	3½	3⅛	2⅛	1	1½
Scullin Gallagher	2	6	6	5½	1⅛	3⅛	3	3⅛	2½	2½
National Steel	2	4½	4⅛	4⅛	1½	3⅛	2½	3½	2½	2½
Buckeye Steel	1½	6½	6½	5½	1⅛	3⅛	3⅛	3⅛	2½	2⅛
Falk Co.	2½	5½	5½	3⅜	1⅛	4	4			
" "	2	4½	4½	3½	1⅛	3⅛	3			
American Steel Foundries	2	6½	6⅛	4½	2	4⅛	4½	3½	2½	2½
Pittsburgh Steel	3	5⅛	5⅛	4½	1⅛	3⅛	3⅛	3	1½	1⅛
Prime Steel	1⅛	6	6	4	1⅛	3⅛	3	3	1⅛	1⅛
Otis Steel	2½	6	5	4⅛	2	4½	4½			
Average	2⅛	5⅜	5⅛	5	1⅛	3⅜	3⅜	2⅜	1⅜	1⅜

SIZES OF TWO FORMS OF NOZZLES USED BY AMERICAN STEEL FOUNDRIES.

MR. R. W. KEMLO has tendered his resignation of the secretaryship of the Sheffield Branch of the British Foundrymen's Association as from the end of the session. Mr. J. Dickinson, 157, Abbeyfield Road, Pitsmoor, Sheffield, has agreed to take up the secretarial duties of the Branch.

Casting Brass in Chill Moulds.

At a meeting of the London Branch of the British Foundrymen's Association on April 23, owing to an alteration in the programme, the evening was devoted to a general discussion of brass-foundry matters. The Branch-Secretary opened the discussion with a short Paper on casting brass in permanent moulds, as follows:—

Die-casting of certain non-ferrous alloys has long been familiar to foundrymen, the features of this work being the use of alloys of relatively low melting points, and casting under pressure in a special apparatus. The alloys usually so cast are those of lead, tin and antimony in varying proportions, aluminium alloys, and alloys of zinc with from 5 to 75 per cent. of other metals, including copper. As a rule, however, the content of copper in die-cast metals does not exceed 10 per cent., though up to 20 per cent. is present in a few mixtures. The high melting point of copper renders difficult the casting of the alloy when about 10 per cent. is exceeded, owing to the mould being damaged by the heat. The relatively high temperature necessary to melt alloys of a high copper content will be readily seen from the following melting points of metals:—

	Deg. C.
Cobalt	1,490
Nickel	1,452
Iron, cast	1,100 to 1,300
Manganese	1,225
Copper	1,083
Silver	962
Aluminium	658
Magnesium	651
Antimony	630
Zinc	419
Lead	327
Cadmium	320
Bismuth	270
Tin	232

When, however, it is recalled that iron, with a much higher melting point than copper, is regularly cast into permanent moulds, it may well be asked why some of the high-copper alloys cannot also be so cast. The reason why copper alloys are not suitable for the usual die-casting apparatus is that the dies in question are made of steel, engraved to give a fine finish to the casting without further treatment. Steel, it is well known, does not stand well against the effects of the continued heating to which casting-machine dies are subjected, and cracking and disintegration take place. Accordingly steel makers prefer suitable cast iron for ingot moulds, as these are found to give a much longer life than steel moulds. Steel ingots, of course, subject the moulds to a much higher and more prolonged high heat than do non-ferrous alloys in the quantities usually cast. The same defect, however, in a lesser degree militates against the use of alloys of high melting powers in steel dies or moulds.

The mixtures suitable for die-casting which are shown in the accompanying table are quoted from E. F. Lake, an American authority. It will be recognised that none of these alloys has a melting point above 500 deg. C., or thereabout, which temperature is not sufficient to rapidly deteriorate a permanent steel mould or die.

Granted, then, that steel is not satisfactory for high-temperature permanent moulds, attention may be turned to cast iron, which has given satisfactory service as moulds for casting iron. The first essential is a low-silicon iron for the mould, to avoid the defect of growth through oxidation of the silicon and carbon under repeated heating. The mould should then be made as cleanly as possible, and designed so that the casting can leave it freely. An important feature in designing for casting in permanent moulds is to prevent the shrinkage of the metal from causing cracks or weak places in the casting. This is not always easy, but often a very slight modification of the details of the design will do much to prevent the trouble. Where dry-sand cores are inserted—these can very well be used in permanent moulds when the casting cannot be cored with the die—they should be of a light, hard nature, but disintegrate and crush under the heat and pressure of the metal as soon as the latter has just set.

As to shrinkage troubles, however, it should be mentioned that success largely depends on ejecting the castings from the mould at the right moment during cooling. All alloys during cooling after solidification display arrests due to the separation of the constituents or phases, and in the case of iron-carbon alloys this fact allows the casting to be turned out and any solid cores removed before the final contraction comes on. The arrests in the case of the non-ferrous alloys, with the exception of those containing a considerable amount of antimony, unfortunately are not so prolonged or pronounced (being rather retardations than actual arrests) to allow advantage to be taken of them; they do not take the form of actual expansions as in the case of iron-car-

Some Alloys used in Die-Moulded Castings.

Kind of alloy.		Zinc.	Tin.	Lead.	Copper.	Antimony.	Aluminium.
		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
	(*a*)	92.6	3.5	—	2	1.5	0.4
		92	—	—	7	1	—
Leddell's		90	—	—	5	—	5
		89	1	—	6	1	3
	(*b*)	88.5	—	—	4.5	—	2.5
		88	5.5	—	5	1.5	—
Leddell's		87.5	—	—	6.5	—	6
Shonberg's		87	10	—	3	—	—
Lumen bronze		86	—	—	10	—	4
		85	5	—	5	—	5
Ledebur's		85	—	—	5	10	—
Salge's		84	9.9	1.1	4	1	—
		83	5	—	10	—	2
Stratton's		82	6	10	1.5	0.5	—
Anti-friction	(*c*)	82	6.5	6.5	5	—	—
Fenton's		79	14	—	6	1	—
Ledebur's		76	17.5	—	5	1.5	—
		74	15	—	5	—	6
		74	12	—	11	—	3
		73	19	—	5	2	1
High copper		47	31	—	20	—	2
Parson's white bronze	(*d*)	38.5	56.5	0.5	2.5	1.5	0.5
Bearing bronze		29	65	—	4.5	1.5	—
Electrotype		—	3	93	—	4	—
Russian railroad car		—	2	90	—	8	—
Ordinary bearing	(*e*)	—	6	87	—	7	—
Jacoby metal		—	5	85	—	10	—
Linotype		—	5	83	—	12	—
Magnolia		—	5	80	—	15	—
Bearing		—	10	80	—	10	—
Railroad bearing		—	10	75	—	15	—
Monotype		—	8	74	—	18	—
Standard white metal		—	5	71	—	24	—
Graphite metal		—	15	68	—	17	—
Bearing		—	10	65	—	25	—
Railroad bearing		—	20	60	—	20	—
Standard type		—	15	58	1	26	—
Hoyle's metal		—	46	42	—	12	—
ta lian railroad car		—	37	38	—	25	—

(*a*) High tensile and low ductility.
(*b*) Phosphor-copper, 4.5 per cent.
(*c*) Heavy duty. (*d*) Analysis. (*e*) Heavy load.

bon alloys. Large cores may often be of cast-iron, particularly when cylindrical in shape, and may be constructed with a centre that can be withdrawn, allowing the core to collapse directly the casting is set.

The early removal of the casting from the mould has the further advantage that the mould is not called upon to conduct away all the heat of the metal. Hence, if a thick mould is used, so as to afford rapid conduct of the heat, it does not become nearly so hot as might be expected. Directly the metal enters, the surface of the casting is slightly chilled and commences to set rapidly, and with the pressure of a good head or riser a dense, strong structure is obtained.

To prevent the molten metal biting into the face of the mould and cores (when metal cores are used) a dressing of plumbago may be applied, and should preferably be rubbed in and polished. If this is done for the first few castings the mould works much better and may serve for several castings on end without re-dressing. Moreover, the mould works better when well warmed, as, for example, after a couple of castings have been poured.

As an alternative to plumbago, various oils have been tried. The writer does not think the use of oils advisable, owing to the generation of gas under the heat of the metal. A far better effect is obtained by swabbing lightly with crude petroleum or some of the other light hydrocarbons when the mould is hot. The dressing then rapidly volatilises but leaves just sufficient deposit on the face of the mould to give a good skin to the casting and prevent the molten metal biting into the iron. The writer has seen this method practised with success. Smoking the moulds with burning resin and by other means is, of course, well known in casting copper in permanent moulds, and forms another alternative dressing.

Experimenters have frequently been troubled, when casting brass and bronze in permanent moulds, with blowholes and similar defects, apparently caused by gases being forced through the metal. It is found in die-casting that the position of the gate and head has a material influence in preventing or permitting blowholes. It is impossible to lay down any rule, the matter being best settled by experience and a little experiment. But it is obvious that it is necessary to gate the mould at a point which will drive the air directly out through the joints and vents instead of trapping it. The nature of the dressing of the mould, also, is very important, for if a material is used which generates gas under heat, such as do various oils of animal and vegetable origin, some of the gases in question will almost inevitably be forced through the molten metal and be trapped there. The air in the mould is a far less serious matter, for after all allowance for its expansion under heat has been made, it is still highly compressible and easily forced out of the joints or vents at the rate the pressure of the poured metal comes in. When, however an oil commences to generate gas in quantities which are relatively large, and this when the molten metal has actually flowed over it, the case is very different, and the gases have to escape through the metal instead of before it.

The ordinary die-casting machine, of course, largely relies on the pressure exerted by the apparatus to eliminate blowholes and similar defects. The metal, also, is cast direct on to the face of the die, no dressing being used. With simple permanent moulds much the same effect is obtained by suitably arranging the gate and giving a sufficient height of head. The size of the gate must be governed chiefly by the nature of the casting and the alloy used, some metals requiring small sprays and others large easy gates which prevent churning of the metal. The height of head, which may take the form of a riser if a deep drop in pouring is to be avoided, governs the pressure exerted on the mould. It should be borne in mind that the diameter of the head is of little consequence; the pressure is not by reason of the deadweight of metal above, but is strictly hydraulic pressure—hence the importance of height. The size of the head should preferably be slightly greater than that of its junction with the casting, in order to retain its fluidity longer; but there is no advantage in pressure gained by a big, low head or riser over a small gate or sprue.

Discussion.

Mr. F. G Chambers (Derby), referring to the dressing of moulds, said he had used with success linseed oil and plumbago, the hot mould being swabbed with that. Had the author of the Paper experienced difficulty with the crushing resistance of cores made with silica sand?

The Secretary replied that the resistance to crushing depended chiefly, when silica sand was used, on the nature of the binder employed. Some binders, while giving an open structure after drying, disintegrated very well under the heat of the metal, and allowed the shrinkage to compress the core sufficiently to avoid cracking.

The Chairman (Mr. A. R. Bartlett) mentioned that in casting an iron ram into a metal mould he had used three parts of loam and one part silica sand for the core. Bottom running was most successful, using a spinning runner, but there was usually a slight defect which took the form of marks as though air had been trapped on the face of the mould from about halfway up to the top. The pouring box was not covered over during pouring. As a dressing for the mould, he had used plumbago and "Binderit," which was dried before using.

Mr. Barber considered that the defect was due, not to air, but to oxide formed during pouring being driven to the side of the mould and rising with the metal. The pouring head should be covered over during pouring.

Mr. Aitken remarked that whenever water was used it was necessary to drive it off, since water expanded to about 1,700 times its previous volume when converted to steam.

Mr. Chambers referred to the casting of a brass liner on to a chill bar, which had given trouble: he had found it best to run it on the flat, in a sand mould, with broad open risers.

Mr. H. G. Barrett described the casting of Babbitt into bearings. He had cast manganese bronze in chills, using steel spindle cores wound with string running spirally and coated with yellow sand. The bottom of the mould was a plate, and the metal was top poured. The core bar was rotated, and the spindle withdrawn when the metal had set sufficiently; but the method was not really a success. A grooved spindle with fine pin-holes in the groove solved the difficulty, and allowed the castings to be made quicker than they could be moulded on a machine.

Mr. Barker referred to certain permanent-mould castings, samples of which he had recently received from France. He had experimented with the matter and had cast several bars of 88: 10: 2 gunmetal, which gave up to 30 tons tensile strength when cast in a die. Turning-bars so cast were too tough to machine, and he had found that the tin could be reduced to 3 per cent. But high pressure through a good head was absolutely necessary. There would possibly be trouble with intricate castings cast in permanent moulds.

A discussion on casting pure copper ensued, the Secretary introducing the subject by a brief Paper. This will be dealt with in our next issue.

White-Iron Castings for Malleableising.

As is well known amongst founders, the iron for producing malleable-iron castings is distinct from that used in ordinary foundry work. It is required to be in the condition known as white iron, *i.e.*, iron with all its carbon in the combined form, whereas ordinary foundry iron should be grey, due to the majority of the carbon having separated out as graphite and amorphous free carbon.

Most grey irons can be cast white, by means of rapidly chilling them before the graphite has opportunity to separate out; but a white iron so produced is not suitable material for malleableising. In the finished malleable-iron casting the carbon is required to be in the form of "annealing" or "temper" carbon—a finely-divided amorphous or non-crystalline form produced by the breaking down of the carbide under the influence of the heat of the annealing process. In grey iron part of the carbon has already assumed the crystalline or graphitic form during solidification of the metal, and hence is in a refractory and quite unsuitable form for malleableising, whilst most of the remaining carbon is in the amorphous form produced by the final recalescence during cooling. With white iron none (or practically none) of the carbon is in the free form, and hence is in a condition to be precipitated as desired by the annealing process.

FIG. 1.—MICROSTRUCTURE OF WHITE IRON; MAG. × 100 DIAM.

Fig. 1 is a photomicrograph of a typical white iron, magnified about 100 diameters. The two constituents shown are cementite (white) and the pearlite (black). Cementite is a carbide of iron, generally considered to conform to the formula Fe_3C, though in iron of the description under discussion other of the constituents, such as manganese, are included in its composition. Pearlite is an intimate mixture of ferrite (pure iron) and cementite. It will be seen that the cementite, which is the hard constituent, is present in two forms, first as excess cementite and second associated with the soft constituent ferrite to form pearlite. The reason for the hardness of white iron will at once be apparent. The change in the condition of the alloy brought about by annealing is well illustrated in Fig. 2, which shows the effect of the heat treatment; the structure is now mainly ferrite (white) and temper carbon (black). Here again is the explanation of the ductile condition of the final casting after annealing, for the structure is very similar to that of a wrought iron, with carbon taking the place of the slag inclusions found in that material. These remarks apply more strictly to the black-heart malleable product, and require slightly modifying in respect to the Reaumur malleable cast iron, in which the elimination of part of the carbon gives a structure more resembling mild steel. This will be dealt with later.

Shrinkage of White Iron.

A feature of white iron that has to be seriously considered by the founder is its high shrinkage dur-

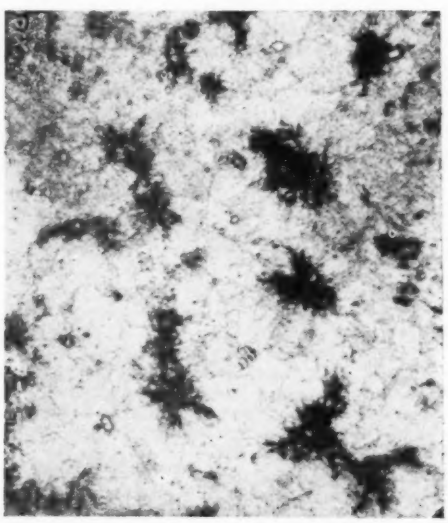


FIG. 2.—MICROSTRUCTURE OF WHITE IRON AFTER ANNEALING; MAG. × 100 DIAM.

ing solidification and cooling.* The chemical distinctions between white and grey iron have been remarked upon, but of equal importance at some stages of the work are the physical distinctions, for the shrinkage of white iron during cooling is much greater than that of grey iron, being about ¼ in. to the foot, as against 1-8 in. for grey iron. This fact necessitates certain modifications in the design of patterns and moulding practice, in gating and feeding, to accommodate the excessive shrinkage. The shrinkage of grey and white iron respectively may be graphically expressed by their respective cooling

* No distinction is here made between liquid and solid shrinkage or contraction, the term shrinkage signifying the total reduction of the final casting from pattern size.

curves (see Fig. 3*). On comparing these curves it will be seen that on the white-iron curve there are neither of the arrests or recalescence points shown on the grey-iron curve and which correspond to the separation of graphite and amorphous carbon respectively. On the white-iron curve only a slight retardation (at about 700 deg. C.) is shown. A non-phosphoric grey iron shows two arrests and expansions, respectively, at about 1,050 degrees C. and 730 degrees C., while phosphoric grey iron shows 3 arrests, at 1,050 degrees C., 900 degrees C., and 730 degrees C., indicating respectively formation of primary graphite, phosphide eutectic and secondary graphite. In white iron only the first arrest is exhibited—that at the beginning of solidification—when the crystallisation of the solid solution of carbon in iron (Austenite) becomes pronounced at 1,060 degrees C.

A cubic foot of pure white cast iron weighs about 475 lbs., and a cubic foot of dark grey cast iron weighs about 425 lbs. The non-separation of graphite in cooling accounts for the lesser volume or greater relative weight of white iron, the structure being correspondingly denser.

Pig-Irons for Reaumur Malleable-Iron Castings.

The pig-iron for this process must be of such a nature that on remelting and casting it will give white castings. In this connection it may be remarked that it is possible to procure a pig-iron which appears to be white but which might be termed a "false white," since it is produced by abnormal casting conditions rather than correct chemical composition. Irons for "malleable" work must fall within certain limits of chemical composition, or difficulty will be experienced in either obtaining a white casting or in breaking down the carbide by heat treatment. The limits for the various elements in the castings are as follows:—

	Per cent.		Per cent.
Total Carbon	1.50	to	4.2
,, Silicon	0.35	to	1.25
,, Sulphur		up to	0.40
,, Manganese	0.10	to	0.80
,, Phosphorus	0.03	to	0.06

The composition of the mixture charged into the furnace should be arranged in accordance with the thickness of the work to be produced, since an iron which would be white in a thin casting would not necessarily be white in a thick one.

Carbon.—Although this is the most important of the elements contained in the iron, it must be viewed in the light of the presence of the other constituents, since they are the chief factors in determining the condition in which the carbon exists. In the days of charcoal irons the carbon content was usually higher than now. In coke irons the carbon content of the grades employed for malleableising ranges from about 2.5 per cent. to 3.8 per cent.

Steel is frequently added to the mixture to reduce the amount of total carbon, but if steel additions are made in cupola melting, there is little likelihood of obtaining this end, though the proportions of other metalloids may be reduced. The reason is that steel in the cupala takes up carbon from the coke. While the cupola temperature, which may be tentatively stated as up to (perhaps over) 1,300 degrees C., is well below the melting point of mild steel, it is sufficiently high to render the steel extremely hot, and in this condition, in contact with the carbon of the charge, some carbon is absorbed, much on the same lines that cementation of iron for blister steel takes place. The carburisation of steel in the cupola naturally is a very much more rapid process, by reason of the high temperature, with the result that the melting point of the iron-carbon alloy thus produced is rapidly brought down to a point corresponding with the cupola temperature. The metal is thus melted before it becomes a fully saturated alloy, though the absorption of carbon does not stop until it loses contact with the coke or the carbon-laden gases in the cupola.

In regard to steel additions to malleable cast-iron mixtures, it is perhaps well to recall that in melting there is some absorption of sulphur and a loss of silicon by oxidation. It would appear that steel additions in the cupola, with the object of reducing the carbon are of doubtful value. In the air furnace, crucible and open-hearth processes of meeting, however, the case is quite different, and it is in the hearth processes that steel additions have so far proved themselves most useful.

Silicon.—This element is chiefly influential in its effects upon the carbon, causing its precipitation as graphite during solidification. Hence the silicon in a mixture for white castings should not be above 1.25 per cent. with carbon up to, say, 2.5 per cent., and should decrease as the carbon content increases. The thicker the section of the casting the lower should be the silicon in relation to the carbon. The silicon might be kept down to a much lower point, were it not for the difficulty in pouring the metal, low silicon being accompanied by lack of fluidity in the molten iron. As a rough guide the following figures may be taken to represent the permissible silicon in mixtures for different thicknesses of castings:—

Thickness. Inch.	Silicon in mixture. Per cent.
¼ and less	1.25
⅜	1.00
½	0.75
¾	0.50
1	0.40
2 and over	0.35

These figures, however, as above indicated, must be taken in conjunction with the carbon content.

It should be remembered that not only the silicon, but also the rate of cooling, is influential in the separation of the carbon, and that an iron with very low silicon may be quite grey if cooled very slowly. In air-furnace practice it is common to reduce the silicon to the desired amount by oxidation during melting, which process produces a hot, fluid iron without excess of silicon such as would prevent the production of white-iron castings. Allowance must be made for the remelting of returned scrap from the foundry, such as gates and sprues, and also castings rejected before annealing, since the silicon content in these is low after melting (which in hearth furnaces is often accompanied to some extent by refining or oxidation of silicon), and this allows the use in the mixture of more of the grey and mottled grades.

Sulphur.—While in American practice the sulphur content of the mixture must be kept down to 0.05 per cent., there are practically no British coke irons which conform to this requirement. Nor is such a low sulphur content necessary in the oxidising or Reaumur practice of annealing. The sulphur should not exceed 0.40 per cent. and should preferably be much less; refined pig-iron for malleable cast-iron work can be obtained with sulphur ranging from about 0.13 per cent. to 0.25 per cent. Lorn charcoal pig-iron, which is largely used for special work, has a low sulphur content which comes within the requirements of the American process.

Apart from the difficulty experienced in annealing when the sulphur is high, that element tends to pro-

*From Turner's Researches.

duce fine cracks in the castings which may not be visible to the eye at first but which are developed by annealing. The higher heat necessary to anneal castings with high sulphur is also detrimental to the finished product.

At the same time it must be admitted that more than the prescribed maximum of sulphur is often allowed in practice, and it is quite probable that a careful balance of sulphur and manganese would give a good result with over 0.50 in the pig-iron, by reason of the manganese combining with the sulphur. Unless working to close analysis, however, such practice is certainly not safe.

Phosphorus.—This element is allowed up to 0.25 per cent. in black-heart or American practice, but in European practice rarely exceeds 0.10 per cent., as low as 0.05 to 0.06 per cent. being the customary phosphorus content for good work. While a certain amount of phosphorus adds to the fluidity of the metal in pouring, an excess causes brittleness and liability to cracking in the castings.

Manganese.—This element to some extent counteracts the effect of sulphur by combining with it to form manganese sulphide. In this respect manganese may be regarded as a desirable constituent, but in excess it causes difficulty in annealing. The maximum allowable in the mixture is about 0.8 per cent., but since few irons for malleable cast-iron work contain more than 0.8 per cent., this is not usually a matter of concern. In air-furnace work particularly, there is a loss of manganese in melting, due to oxidation. It is claimed by some writers that a manganese content of over 0.4 per cent. retards the separation of the temper carbon, but the writer has not seen any data which confirms this contention.

The following are the makers' analyses of a number of British irons whose composition falls within the prescribed limits for malleable-iron castings.

Brands.	C.C.	G.C.	Si.	S.	P.	Mn.
WHITE IRONS.						
Millom	3.000	0.100	0.560	0.150	0.038	0.200
Lorn (charcoal)	2.820	0.100	0.118	0.004	0.050	0.180
M.H.M. (white)	3.000	0.110	0.500	0.150	0.037	0.200
M.H.M. (spotted white) ..	3.100	0.100	0.600	0.160	0.037	0.200
Tyneside hematite ..	3.500	0.400	0.500	0.200	0.055	0.600
S.C.M.	3.250	0.200	0.400	0.220	0.050	0.250
Askam	2.800	0.300	0.490	0.160	0.040	0.200
MOTTLED IRONS.						
Millom	1.700	1.500	0.550	0.130	0.036	0.250
Lorn (charcoal)	1.500	1.820	0.530	0.004	0.060	0.050
M.H.M. (hard mottled) ..	0.770	2.600	0.910	0.200	0.036	0.200
M.H.M. (soft mottled) ..	0.740	2.100	0.740	0.160	0.036	0.200
Tyneside hematite ..	1.500	2.000	0.800	0.100	0.054	0.800
Askam	1.600	1.500	0.600	0.150	0.039	0.190
GREY IRONS.						
Lorn (charcoal)	0.950	2.320	0.522	0.007	0.061	0.216
Millom, No. 5	1.330	2.600	0.900	0.130	0.034	0.400
S.C.M.	0.600	2.900	1.500	0.120	0.050	0.400
Askam	1.200	2.500	1.000	0.140	0.038	0.800
M.H.M.	1.000	2.400	1.200	0.130	0.036	0.200
Moss Bay	0.450	2.800	1.300	0.100	0.040	0.500

It will be noted that although the casting is required to be white the pigs used include grey, mottled and white. These are used in proportions governed by the class of work, the amount of white scrap used, and the amount of steel (if any) added to the mixture. The grey iron is that known as No. 5, a hard iron with silicon not usually over 1.25 per cent. This iron is unsuitable for ordinary grey castings, since it borders in composition and hardness on mottled iron. The mottled iron has still lower silicon, and the appearance of the fracture denotes that it approaches white iron in nature.

As a general rule it may be stated that the thinner the casting the more mottled or grey iron may be used; and the heavier the casting the more must the mixture be composed of white iron. Some foundrymen attempt to calculate for different work by reckoning varying proportions of grey, mottled, white, and hard scrap respectively, regardless of the chemical composition. This method is satisfactory when the irons are known and reliable, but where strange irons are used it is safer to pay regard to the chemical analyses of the charge. The chief elements to be considered (unless an excess of one element in a pig-iron is required to be corrected by another pig-iron low in that element) are silicon and carbon, as the other constituents, phosphorus, sulphur and manganese, do not vary sufficiently in the grades of the same iron to materially affect the mixture.

Treatment of Scrap.—The hard or unannealed scrap produced in the foundry should be tumbled or otherwise cleaned of sand and can then be used again in the furnace, taking care that any "burnt" scrap is distributed over several heats so as not to detrimentally affect the metal. Annealed scrap is also used in the mixture by some founders, while others prefer to employ it only in the making of the

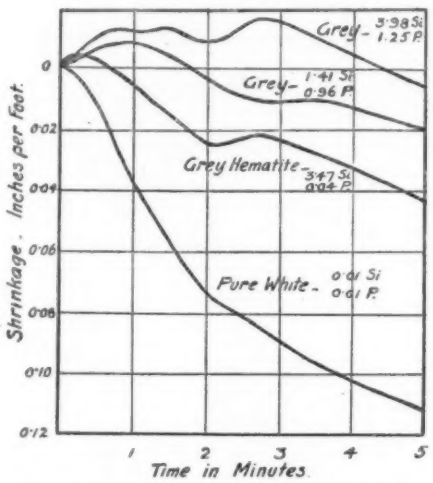


FIG. 3.—TYPICAL COOLING CURVES OF GREY AND WHITE CAST IRONS.

annealing boxes or pots. Rusty metal is not desirable in the mixture for white castings. As regards steel scrap, almost any class of steel from boiler-plate punchings to castings is usable in the mixture.

Pig-Irons for Black-Heart Malleable Cast-Iron.

As previously indicated, the chief distinction between iron for black-heart and Reaumur practice respectively, is in the sulphur, which for black-heart should not exceed 0.07 per cent. in the casting. According to Dr. Moldenke, the composition of a good malleable iron casting is as follows:—

		Per cent.
Total carbon (before annealing) ..	.. above	2.75
Silicon	.. ..	0.45 to 1.00
Sulphur	.. up to	0.07
Phosphorus	.. up to	0.225
Manganese	.. ..	0.30

Taking these elements individually:—

Carbon in American irons, according to some writers, does not usually require to be specified, the contention being that pig metal which has the other elements within requirements carries a suitable total carbon. The carbon, however, may be brought below

the required amount when steel additions are made to the mixture, when the silicon also may be so far lost in melting as to disturb the correct ratio of carbon and silicon. So far, then, the carbon should be specified.

Silicon.—As in Reaumur practice, the silicon may exceed the limit above stated if the castings are very thin, 1.25 per cent. not being unusual for such work; while for heavy castings, where fluidity is not so essential and where the castings cool more slowly, the silicon may be down to 0.45 per cent. With charcoal irons 0.35 is claimed to give the best results.

Sulphur.—While the maximum limit for sulphur is set at 0.07 per cent., a lower amount should be and is generally aimed at, 0.04 being set as a desirable figure. Certainly the limit of 0.07 is at times much exceeded, but the resulting product is distinctly inferior metal and does not come within the range of good black-heart malleable cast-iron. As previously explained, the effect of excess of sulphur is to prevent the precipitation of the carbon during annealing, giving a hard and weak iron. Therefore 0.05 per cent. sulphur in the pig metal is usually specified as the permissible maximum. Undoubtedly, however, the proper balance of manganese and sulphur will allow the normal sulphur content of the pig-iron to be considerably exceeded.

Phosphorus.—This element is usually higher in American or black-heart irons than is permitted in Reaumur practice. The maximum is set at 0.225 per cent., none being lost in the melting or refining. This maximum, however, is usually only touched in charcoal irons, the coke irons used having usually phosphorus contents of from 0.1 to 0.2.

Manganese.—The manganese, though given as 0.30 in the casting, may go up to 0.60 per cent. or over, since there is a loss by oxidation, or "burning out," in the melting process. It is not advisable to have the manganese high (unless to counteract high sulphur), for it may possibly cause trouble in annealing, and it is doubtful whether it combines to any considerable extent with the sulphur in low-sulphur American irons.

The writer's attention has been drawn to the charcoal irons produced by the Superior Charcoal Iron Company, Michigan, U.S.A.* The analyses of these are given as follows, the grading being on the basis of silicon content:—

Grades.	Silicon.			Chill.
	Min.	Average	Max.	
	Per cent.	Per cent.	Per cent.	
Low 1	1.63	1.75	1.87	—
High 1	1.38	1.50	1.62	—
Low 2	1.13	1.25	1.37	—
High 2	0.88	1.00	1.12	—
Low 3	0.63	0.75	0.87	Trace to ¼ in.
High 3	0.50	0.56	0.62	¼ to ⅜ in.
Low 4	0.38	0.44	0.50	⅜ to 1 in.
High 4	0.25	0.32	0.38	1 to 1½ in.
Low 5	0.15	0.20	0.25	Low mottled.
High 5	0.05	0.10	0.15	White mottled.
No. 6	0.00	0.00	0.05	White.

Sulphur in these irons is given as 0.025 per cent., the phosphorus as ranging from 0.15 to 0.22 per cent., and the manganese from 0.30 to 0.80 per cent. according to grade, the softer grades containing the higher percentages of manganese.

Mixtures as Affected by the Melting Process.

In calculating the mixtures for any particular class of work, due regard should be paid to the melting process and its effect in changing the composition of the iron.

Crucible Furnaces.—The crucible melting process still retains much of its popularity amongst European founders, despite its expense, for it is subject to less irregularity than the other processes. Obviously the oxidation of any constituent will be less in crucible melting than, say, in the open hearth, where heating takes place practically in direct contact with the metal. In fact, no refining takes place in crucible metal, the metal coming out with the same composition as it goes in.

Cupola Melting.—The cupola probably ranks next, for the metal is only in contact with the fuel and furnace gases for a comparatively regular period, and the loss of silicon can be calculated with fair certainty if the furnace is properly worked. The loss is generally 0.25 per cent. of the silicon content, 0.8 giving about 0.6 per cent. in the castings. The rules applying to cupola practice for grey iron may be said to apply equally in the case of white iron. Excess of coke should be carefully avoided, or the iron may take up too much carbon in the furnace and not be sufficiently hot to run properly. The blast should be regulated both as to quantity and pressure to avoid undue oxidation.

Air-Furnace Melting.—In this process of melting the reduction of silicon is somewhat greater than in cupola melting, the loss being about one third of the original silicon content. Thus, 0.80 per cent. of silicon in the pig would give about 0.53 per cent. in the casting. This loss varies somewhat according to the operation of the furnace, but the figure quoted may be taken as a fair average.

Open-Hearth Melting.—In this process not only are the oxidation losses higher than in either of the others, but irregularities are more likely to occur if the melting is not controlled properly. The silicon loss may be 75 per cent. of the original content if care is not exercised. For this reason it is customary to keep a supply of ferro-silicon at hand to add to the bath when evidence of undue oxidation is evinced. Despite the possibility of irregularities however, the open hearth ranks as the best furnace for the work, particularly if a tilting arrangement is fitted so that the top of the metal (that which is most refined and hottest) can be poured first.

Bessemer Process.—A practice which has been adopted in some European foundries is that of refining the metal in the Bessemer converter, after melting in the cupola—not de-siliconising to the same extent as for steel making, but stopping the process at an intermediate point and adding aluminium as a deoxidiser to the bath after blowing. This process, however, does not suggest any advantage over the others mentioned, and in fact is very liable to result in irregular metal.

* London Representatives: Frodair Iron and Steel Co., Ltd.

REAGENTS FOR ANALYTICAL PURPOSES.—A book has been issued by the Institute of Chemistry, 30, Russell Square, London, W.C., giving a list of reagents for analytical purposes, with notes indicating the standards of purity regarded as necessary for analytical work. One of the objects is the recovery of that portion of the trade in fine chemicals for analytical purposes which, through several causes, has been attracted away from this country. The ability of our manufacturers to supply the great majority of such materials in a sufficient degree of purity is already established, and it is believed that if the necessity of applying to foreign firms for a few highly purified materials be removed, the habit of unnecessarily purchasing abroad other products might be checked, to the advantage of British manufacturers and chemists.

Industrial Organisation.

At a general meeting of the Sheffield and District Branch of the British Foundrymen's Association on April 19, Mr. T. H. Firth (President) in the chair, Professor W. Ripper, Dr.Eng., the head of the Applied Science Department, Sheffield University, delivered a lecture entitled "Modern Industrial Organisation and Method." He defined organisation as the introduction of system, method, and intelligent direction in place of what would otherwise be self-destructive effort. Our resources in all departments were rapidly increasing, and therefore the best methods for to-day were not those of yesterday. Organisation, therefore, must be progressive. There was no department of science which provided more interesting examples of the economical effects of progressive development than that of power engineering. There had been an extraordinary growth of efficiency, due to the policy of devoting continuous attention to the subject of the elimination of waste, and to the noting of the effects on economy of small changes and improvements in plant. He urged that similar methods must be applied to the organisation of business generally. After the war, there must be a war on waste—waste of time, material, effort, human life—in business organisation. For this to be successful, however, the old spirit of war between class and class, capital and labour, employer and employed, must surely go and a new spirit—a saner and wiser spirit of combined and co-operative effort—take its place. They had been too ready in the past to adopt a position of mutual enmity and mistrust, instead of one of mutual inter-dependence and consideration, and had never realised the enormous waste which accompanied this attitude one to the other.

Both management and workers had equal responsibility for the reduction of standing charges. The more perfect and suitable the equipment, the more efficient the workers, and the more loyal their co-operation, the greater the output, and the less the proportionate cost of production. It was to the interest of the workers to do all they could to decrease the overhead and fixed charges. They did not seem to be aware of this fact, but with the spread of education the realisation of it was bound to come. To fail to make the best use of the plant increased the cost of the work done, and decreased therefore the margin available for increase of wages. The most effective way of obtaining the most out of a highly efficient plant was to have highly efficient labour, and the best way to secure efficient labour was to pay a good price for it. Low-paid labour was rarely efficient, and was dear in the end.

Dr. Ripper then dealt with the internal organisation of business, and the necessity of constantly keeping to the fore the questions of the improvement of the conditions of work and the methods of operation. Care should be taken to locate sources of loss throughout the whole process of manufacture from the raw material upwards. Careful study of operations on these lines determined that the most suitable machines were selected for the work to be done, heavy work for heavy machines, and not small jobs done in a machine two or three times too big for the purpose. Costs were also kept down by keeping machines constantly running, one man to one job, and not frequent changes of work in the same machine or for the same man, the effect of which would be to waste the time of both the machine and the worker. Care was taken to secure the best combination of speeds, feed and cut; the preparation of special tools to secure indefinite repetition of processes with perfect accuracy and interchangeability; the preparation of tools and of work beforehand so that there was no waiting either by men or machines, and as little time as possible lost between operations; facilities for handling work, placing it in the machine, taking it out, and securing its efficient running through the factory; that the plant was laid out with the utmost regard to economy of the distance travelled between operations; the checking and inspection of materials and of work done; care that repairs were carried out outside the working hours of the plant; and the efficient maintaining of the tool room so that tools were always ready when needed, and delivered beforehand.

These conditions represented, of course, a counsel of perfection, and could only be carried out perfectly in branches of manufacture where the product was more or less of a standard pattern. As a works found itself engaged in more and more complexity of types of work, the operation of economising times and processes became more and more difficult to realise, and this difficulty of avoiding waste as complexity of manufacture increased accounted for a strong tendency towards specialisation and standardisation of work.

He dwelt on the value of industrial combinations, such as had been carried out more especially in the United States and Germany. Separate firms engaged in the various branches of a great industry from the raw material to the finished product had joined themselves together, to form one united combination. These combinations possessed an increased power of handling problems on a large scale, and of introducing economies otherwise impossible. They were also better able to withstand the effects of depression in separate sections of industry, being able at any time to concentrate their strength upon the department demanding the greatest activity of output by drawing upon the strength of the departments less fully occupied. They were also able to utilise their waste material and waste heat for by-product purposes, which the smaller firms would not find it worth while to do.

In another class of combination, different firms engaged in the same industry and at the same stage of that industry united, thus substituting combined action in the place of independent rivalry, with its inevitable consequence of loss and at times of disaster. Competitive industry had done a great deal for the development of commerce and manufacture, but it had proved itself incapable of entirely fulfilling all that had been expected of it. Combinations aimed at preventing the loss which resulted previously from underselling by discounts, rebates, conditions of delivery, etc. The central organisation determined in many cases the total output of the works, allotted the work in shares to the various firms, fixed the price and conducted all business between the producer and the customer. They also possessed all the advantages of a large scale industry, by distributing one branch of manufacture to one set of firms and other branches to other firms, thus securing increased efficiency in processes, with correspondingly reduced cost per unit of output. They had also the power to purchase on more favourable terms, and to utilise their waste material in the form of by-product industries, to save in costs of packing and transport by selling in large quantities, and to greatly reduce their cost of selling by saving in cost of ad-

vertising and in reduction of the number of travellers and agents.

After discussing the advantages of specialisation in manufacture, and of a good costing system, he referred to the need of trade schools for the efficient training of apprentices, and dealing with boys from the time of their leaving the elementary schools. The introduction of these trade schools was the most pressing need educationally in the interests of the trades. Referring to the present needs of the nation in the supply of munitions of war, he said that during the next few months the world would learn the meaning of the full weight and power of British engineering resources directed to this one end. Our armies and the armies of our Allies might confidently depend upon it that those supplies would continue to increase in volume and in intensity till the menace to the peace of Europe was removed once for all.

Discussion.

The PRESIDENT said that one of the points in the lecture which struck him most was that of getting the maximum output out of the machines. That applied not only to machines but to men. In foundry practice, they found the difficulty of getting the maximum output out of the men. It would be well for them to apply Dr. Ripper's principles to the foundry, and to see that the moulder had everything put to his hand, so that it was impossible for him to be slack and waiting for anything. He hoped that the days when men were not allowed to do as much as they wished were disappearing. Certainly, they were not having as much trouble as they had had. One thing they had lacked in England was the readiness to tackle an order for something that was a little out of the ordinary. He thought the war was going to wake them up in that respect.

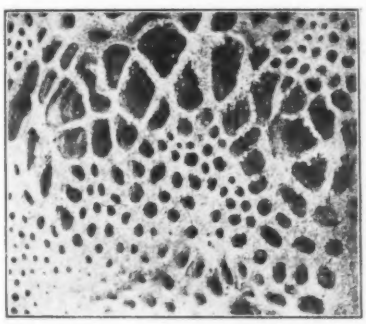


FIG. 1.—MICROGRAPH OF HONEYCOMBING IN STEEL.

MR. ARTHUR BALFOUR, referring to some slides of the Ford Motor Works which Dr. Ripper had exhibited, said the organisation there was possible because of the great number of things of one pattern that were turned out. One of the greatest handicaps of firms in this country was that they had to make so many different kinds of articles, which were not suitable to be made on the same machine or in the same melting furnace. If groups of manufacturers could work together—if each works could be deputed to make one kind of thing—many of their difficulties would be overcome.

MR. JOHN LITTLE, comparing American methods with English, said the difficulty with us was not want of organisation but want of trade. If we had a demand similar to that which was experienced by the American works, with their huge outputs, we could do as well as they did in America, and certainly a lot better than they did in Germany.

DR. RIPPER was heartily thanked for his lecture.

Honeycombing in Steel.

To the latest issue of the "Proceedings" of the Cleveland Institution of Engineers MR. EDWARD CROWE contributes a note explanatory of micrographic sections (see Fig. 1 herewith) illustrating a unique case of honeycombing in steel. It appears that a furnace was tapped into the casting ladle in the usual way. On attempting to team into the ingot moulds it was discovered that the stopper hole was blocked, and all efforts to clear the hole were fruitless. In the meantime, the steel had set on the top, sides and bottom of the ladle, to the extent of about 4 in. to 6 in. on the top, and 1½in. on the sides. The ladle was in this condition turned over, and the whole of the liquid steel ran out through the hole in the top crust left by the stopper rod.

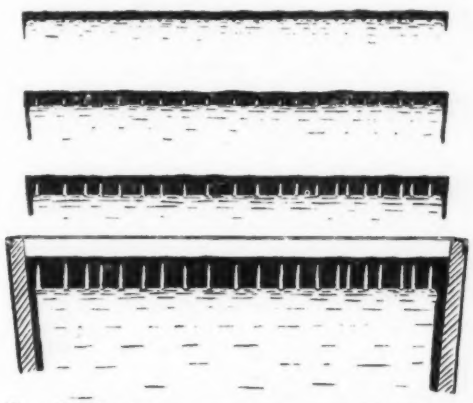


FIG. 2.—DIAGRAMS SHOWING HOW BLOWHOLES DEVELOP DURING SOLIDIFICATION OF SURFACE LAYERS IN LARGE MASSES OF STEEL IN A LADLE.

On cutting up the skull, it was found that the underside of the top crust presented, over practically the whole surface, a remarkable honeycombed appearance. The photograph (Fig. 1) illustrating this was taken by Dr. Stead. The diagrams (Fig. 2) indicate the process by which these honeycombs were formed. Gases being given off at various points, on the underside of the top crust would form independent bubbles, round which the steel gradually grew. The size of the holes would therefore depend upon the quantity of gases disengaged at any one point. It is obvious also that when the quantity of gas given off at any part became greater than was sufficient to fill the holes, the surplus would overflow and form larger bubbles covering up some of the smaller ones. That this occurred is shown plainly on the diagrams, for the small blowholes are in hollows, and round the hollows are larger blowholes. It is also obvious that such large honeycombing cannot develop on the sides or bottom of the ladle, as the gas would escape and float upwards as soon as liberated.

Wrought Iron and its Future.

At a meeting of the Newcastle-on-Tyne Branch of the British Foundrymen's Association recently a Paper on "The Manufacture of Wrought Iron and Its Future" was presented by Mr. H. Pilkington. In the course of the Paper the writer remarked:—The manufacture of wrought iron has for many years been considered a dying industry, but in the last year or two a considerable change has come over the situation, and there is an immense revival in the demand for wrought iron, purely and simply because of a definite appreciation of its marked superiority, in many respects, over its rival—steel. There is not much difference in principle between the ordinary open-hearth steel process and puddling, except in the final part of the process. In puddling the final product consists of balls of iron sponge, while in the open-hearth steel furnace it is fluid steel or "ingot iron." Ingot iron, however, must not for one moment be taken as being comparable in any way with fibrous wrought iron. The laborious part of the operation of puddling, of course, comes in in "rabbling" and "balling" and abstracting these balls from the furnace. These operations do not obtain in the case of open-hearth steel making, and, however attractive the occupation of puddling may be made by better remuneration or shortened hours of work, it is quite clear that some mechanical form of puddling is highly desirable. Mechanical rabbles, often tried, are obviously failures, and do not nearly touch the kernel of the whole matter, and it is, therefore, clear that whatever form of mechanical puddling is introduced, it must be such that "rabbling" and "balling" and the delivery of the sponge from the furnace are done mechanically, without labour, and in such masses as will be sufficient to produce a bloom corresponding to the size of a steel ingot, such a bloom, when heated, being rolled off into billets, or into the finished material, without the intervention of piling, in a somewhat similar manner to that which now obtains in steel works when dealing with an ingot.

Dealing with the strength and resistance to shock of wrought iron, the writer continued:—The more rolling down, or work, put upon the iron, the finer its fibre becomes, through the rolling out of the grains into fibres enveloped in slag; but also, the more rolling down of the material, the more of this slag is excluded and expelled, and any oxide of iron or slag which may be intermingled in the fibre, in the form of isolated spots or patches, is exuded or distributed by the heating and rolling out, until the resultant bar becomes free from any such irregularities. Such iron as this does not stand tensile strains, but gives the highest possible contraction at the point of fracture, and also gives the highest possible elongation, while, on the other hand, puddled bar which is rolled straight off, produces iron technically called "young," and with large grains, and assuming that the original material, *i.e.*, the pig-iron, is good, and that the puddling has been well done, will in this form produce the highest possible tensile strength, as well as the best welding qualities. But whatever method of piling and re-heating or intermixture is used in these piles, it is obvious that owing to this process wrought iron is essentially a bundle of fibres, absolutely welded together and not to be dissociated. Any shock, therefore, coming on such a bundle of fibres, must be very great indeed, relative to its section, if it fractures them all, whereas any such shock on mild steel might fracture the whole section very quickly after the first surface crack occurred, as in this case there is no resistant fibre in the structure.

There is no doubt whatever that many grave mistakes were made in the application of steel for many purposes where resistance to shock was primarily a necessity, because this country as well as many others, rushed into the manufacture of steel almost in a panic, and the use of steel was introduced for many purposes which may now be regarded as mistaken, and not in accordance with experience. In this respect it is rather curious to have watched the evolution of basic mild steel, but apparently it has not been permitted to be used in this country for boilers and for rail making, except to a very small extent. In these cases the practice has been confined to the use of comparatively high-tensile acid steels, although it might have been thought that boilers should have been made of more ductile material than acid steel. Among the many other grave mistakes which have been made by the substitution of steel for wrought iron might be mentioned the cases of crankshafts for engines, connecting rods, crankpins for locomotives, and bolts for pumps and water services generally. In the case of railway wagons, although some people have had dreams of steel chains, coupling links are still made of wrought iron, for two simple reasons; first of all, their fibrous nature resists shock far better than steel; secondly, steel links will not weld properly and securely. There is no successful steel coupling, although several have been tried and are on trial still.

In the case of cable chains for ships, it is, of course, well known that they are all made of fibrous wrought iron, and there is no successful substitute at present, and as far as the writer is aware, being an extensive maker of Admiralty and other irons for ships' cables, no attempt with regard to steel has yet been countenanced.

Another very interesting point, often little considered, with regard to wrought iron, is that it is capable, by means of case-hardening, of being carburised and hardened. The cementation process as practised in Sheffield is, of course, by a different method—the carburisation of wrought iron for the production of the hardest and finest steels. It is well known to all engineers who for many years have practised case-hardening, that if similar sized articles, one in iron and one in steel, went through this process together, under precisely similar conditions, the wrought-iron article would show a deeper hardening, and a harder one, than the steel article. Moreover, it is pretty obvious that the remaining fibrous core in the wrought-iron article must be far better capable of withstanding shock than the core in the steel article, which is not fibrous. There is little doubt that this process, or a similar one, is capable of far wider application than has hitherto obtained, and although it is a process now being extensively used by engine builders of all sorts, it is obvious that there are many other purposes to which it could be usefully applied, particularly where an intensely hard wearing surface is necessary, together with an internal core of fibrous ductile material.

One of the most important points as between the use of wrought iron and mild steel is the question of fatigue which occurs in both materials. The writer's experience with regard to crane chains, shingling hammer rods, crank-pins of locomotives, and many other parts of machinery, points con-

clusively to the fact that whether in iron or steel the deterioration by crystallisation, due to fatigue, is an extremely serious factor in both materials, and one which has to be faced and dealt with in practice. Even taking the case of iron chains, for there are no other sorts of chains of any account, the practice is to anneal them at least once a year to restore them from a crystalline condition (due to fatigue caused by vibration and shock) to the fibrous state again, and if any life was lost by the breakage of a chain the first thing His Majesty's Inspector would want to know would be when the chains were last annealed. Annealing is a species of rest cure.

In taking the cases of such materials as crank-pins and shafts, this crystallisation has always been observed by engineers, and is well known, but the opportunity of annealing and restoring the crystalline structure is not so possible as in the case of chains and other such articles; but there is any amount of evidence that such crystallisation does occur, particularly in the case of locomotive engines subject to sudden reversal.

The future of the extensive use of wrought iron, however, is fully assured if it is only from the point of view of its powers of resisting corrosion in contradistinction to the great liability to extensive corrosion from which mild steel suffers, and the much greater life which wrought iron enjoys in consequence. The writer has blast-furnace casings of wrought iron at work now which are 7/16 ins. and ⅜ ins. thick, although they have been at work over fifty years. It must be remembered that the atmosphere surrounding a blast furnace is considerably impregnated with acid forming gases, particularly sulphurous gases from the slag tuyeres as well as carbonic acid (CO_2) and carbonic oxide (CO); but in all cases of blast-furnace stoves and casings made of wrought iron, the outside of the casings exposed to the atmosphere have only slightly wasted, perhaps because they are well painted, while it is the internal parts of the casing which are affected, where they are subject to the influence of the gases named, as well as to warmth and moisture.

Mr. Paulin remarked that when he was an apprentice he had had experience of some German iron, and it was the finest material he had ever seen, and well adapted for welding. Everyone was familiar with the condition into which iron got after receiving repeated shocks, showing large fractures, due perhaps to fatigue. When a chain reached that condition, it was annealed, but he could hardly believe that such an operation would bring it back to its original state. He took it that all chains were iron, and he had found that when once they began to go it was not worth while to repair them. As to the curious snapping of steel, referred to by the writer as due to continual alteration of the stresses, he had noticed this and had observed that there were rings in the steel gradually working towards the centre. Week after week it was possible to observe the effect of the fatigue, and the result of the air getting into the crack, fresh areas being exposed every day to the atmosphere. There was one point in which he considered steel had a decided advantage over iron; it was not possible to get the same rigidity in iron. As regards iron standing against corrosion, everyone would remember how the iron-built ships were able to stand.

Mr. Vardy said that in shipbuilding he thought it was quite recognised that iron was good, but it was not possible to obtain any. What was obtainable was a form of mild steel. He thought the question was mainly a commercial one. The manufacture of wrought-iron plates in large sizes had not yet been accomplished. The larger the plates used in shipbuilding the better. In modern shipbuilding the plates used were sometimes 40 feet long. There was also the question of tensile strength, which was a very important matter. The object of the owners was to make the ship a business proposition, and wrought iron would remove a certain amount of holding capacity. He had had experience of the use of iron chains, but he preferred wire ropes. The benefit of annealing as a "rest cure" for iron chains might be great, as it served to indicate where the welds were showing signs of giving way. The wire rope, however, was to be preferred, because of the notice it gave of giving out. As to wrought iron lasting for a long time, there was no doubt that for resisting corrosion it was preferable. Wherever the material was called upon to withstand corrosion, such as in the case of loco. fire boxes, where there was bad treatment due to sudden heating, wrought iron was superior to steel, but he preferred copper. He hoped that the iron-makers would be able to bring the price of wrought iron down to something that would be reasonable. As regards German steel, it was possible to get either good or bad, but many shipowners would not approve of the use of German steel. On one occasion he had written to some friends in Germany asking them to recommend a good German furnace steel, but they had replied to the effect that they could not.

The Chairman (Mr. J. M. Weir) said he quite agreed with Mr. Vardy that wrought iron was preferable on account of its resistance to corrosion. Had he known the discussion would have gone in this direction he would have brought with him a sample of wrought iron obtained during some excavations at his establishment, one of some pieces from the first railway laid in South Shields. After so many years underground and partially exposed above ground, these rails were still perfect. For haulage he would not employ chains. In one instance in his experience, he had narrowly avoided injury from a 4-ton ladle of molten metal, and if this had been lifted with a chain instead of a wire rope he would not have had the warning which enabled him to get clear.

A vote of thanks to Mr. Pilkington terminated the proceedings.

EFFECTS OF POURING TEMPERATURES.—At a recent meeting of the London Branch of the British Foundrymen's Association the discussion turned on the question of ideal temperatures for pouring non-ferrous alloys. Mr. Neil remarked that the size and thickness of the casting to some extent governed the temperature. The Branch Secretary contended that, though writers often insisted that the correct pouring temperature was very important in order to secure the maximum physical properties, the temperature in question was for almost any alloy represented not by a point but by a comparatively wide range—in some cases 25 deg. C. at either side of a point. Mr. E. M. Boote agreed that the range must be considerable, but to heat too high and cool down to the proper temperature generally gave bad results; for example, to cool down from, say, 1,200 deg. to 1,050 deg. as the pouring temperature had usually an ill effect. Mr. F. G. Chambers remarked that he judged by visual observation. With manganese bronze, for example, the metal should be heated until the zinc fumes flared, the pot then pulled out and the metal skimmed and poured when the zinc flare ceased, but resumed on being poured into the mould. With ordinary bronze the metal should be poured when a skin formed from the side of the pot across the metal. Mr. F. C. Barker said that 88:10:2 gunmetal should not be overheated, but if poured below a certain point it lacked strength. He found it best to push back the charcoal from the metal and observe the surface; when rainbow colours showed across the metal it was ready for pouring.

Scales for Weighing Projectiles.

It requires no technical knowledge of projectile manufacture to enable one to realise the immense importance of fine accuracy in the weighing of shell. Obviously, what is required for the purpose is a

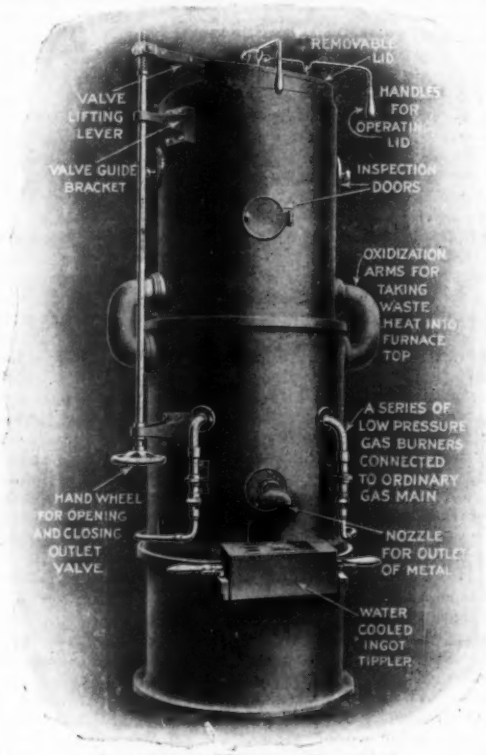
FIG. 1.

weighing machine which, whilst of strong design, is delicately sensitive, accurate and reliable, and also adapted to the on-and-off loading of heavy weights with a minimum of exertion and fewest motions.

FIG. 2.

Types which have found favour with shell manufacturers are illustrated herewith in Avery's pillar scale (Fig. 1), and tripod scale (Fig. 2), made by Messrs. W. & T. Avery, Limited, of Birmingham.

The pillar scale consists of a special forged-steel beam, 6 ft. centre to centre, fitted with extra long hardened knife edges of stock section—which can easily be replaced—and provided with a down-pointer moving over a graduated sector plate. The height of the pillar is approximately 8 ft., and the head is strengthened to carry an extra long middle bearing of hardened steel. The relieving gear is a cast-steel box with toggle action, which facilitates loading and unloading. The scale can be fitted with a plain goods plate for weighing standing shell, or with a forged cradle designed to weigh shell in a horizontal position, or by a combination of both as shown in Fig. 1. Despite the high capacity of this scale (25-cwts.),


REMOVABLE LID
VALVE LIFTING LEVER
HANDLES FOR OPERATING LID
VALVE GUIDE BRACKET
INSPECTION DOORS
OXIDIZATION ARMS FOR TAKING WASTE HEAT INTO FURNACE TOP
A SERIES OF LOW PRESSURE GAS BURNERS CONNECTED TO ORDINARY GAS MAIN
HAND WHEEL FOR OPENING AND CLOSING OUTLET VALVE
NOZZLE FOR OUTLET OF METAL
WATER COOLED INGOT TIPPLER

ALUMINIUM MELTING FURNACE.

the apparatus complies with the requirements in weighing apparatus qualified to rank under Class which means, in a 25-cwt capacity beam, that the greatest error allowable when fully loaded is limited to very slightly over one ounce and a half, and that the loaded beam must respond to the influence of less than one ounce.

Avery's tripod scale (Fig. 2) is constructed of drawn steam tubing, with replaceable extra long hardened-steel standardised bearings and end knives. A cradle goods-end is fitted, as shown, for weighing shell in a horizontal position.

A New Melting Furnace for Aluminium.

The application of aluminium and its alloys to industrial purposes has extended considerably in recent years. Generally, the melting of these metals has been effected in open crucibles, which allow at-

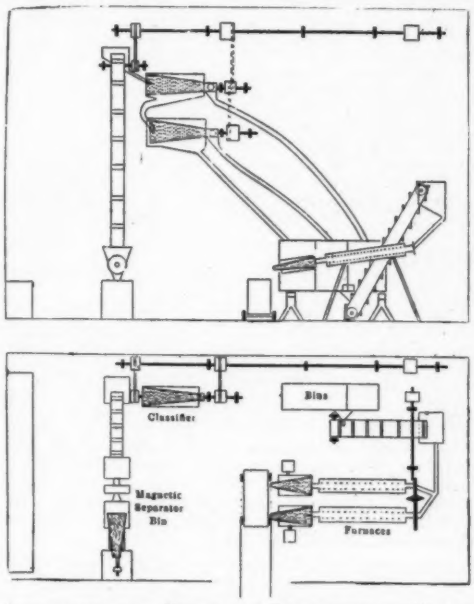
mospheric oxygen to attack the molten metal with the consequent formation of dross. Other drawbacks to melting aluminium in this manner are well-known to those familiar with the subject. A gas-fired furnace for melting aluminium and its alloys has been evolved by the manufacturers, the Monometer Manufacturing Company, Limited, Whitehouse Street, Aston, Birmingham, in which the difficulties usually met with are claimed to have been overcome. Melting pots made of metal are subject to the objection that the re-action which takes place between the molten aluminium and the impurities in the metal of which the pot is composed spoils the aluminium. In the furnace in question this reaction is eliminated by the employment not only of a special composition of metal, but as a considerable proportion of the molten metal goes to waste as oxide, the melting pot is installed in a chamber containing *inert* gases incapable of oxidising the molten metal. As there is no oxidation it follows that there is no dross. The method of constantly replenishing the enclosed melting chamber with inert gases consists in causing the products of combustion to traverse the melting chamber on their way to the outlet flue.

As regards the heating arrangements, the thermostat of the patented regulator, termed by the makers a "monometer," controls and governs the quantity of gas supplied to the burners, so that immediately the aluminium is melted the quantity of gas combusted by the burners is reduced and the uniform heat essential to the melting of aluminium is automatically maintained. The Bunsen burners under the melting pot have contracted nozzles of such a design that a proper admixture of the gas and air takes place. The heat obtained by these low-pressure atmospheric burners, which are coupled to the ordinary town supply, is comparable with that attained by high-pressure gas, but without using compressors or fans. The equipment of the furnace is completed by a central cone valve seated in the bottom of the melting pot and controlled by a conveniently-arranged hand-wheel, by which the molten metal issuing from the pouring spout can be regulated to a nicety or entirely shut off. At the top of the furnace are located two doors through which the swarf or metal is introduced into the melting pot, these doors being balanced so that they remain either in the closed position or in the open position, without being held by the operator. The furnace is mounted on a wheeled carriage which can readily be moved on the rails from one part of the foundry to another, flexible gas pipes providing the means for taking up this movement of the furnace.

Separation of White-Metal and Gunmetal Borings.

Writing in "Metallurgical and Chemical Engineering," Messrs. R. H. Walton & G. T. Bailey, of New South Wales, Australia, describe a process for the separation of white-metal and gunmetal borings. In locomotive machine shops there is produced a large quantity of gunmetal borings mixed with white metal, which, in certain cases, is very difficult to deal with. "So far as we are aware," the authors remark, "the only method used for effecting a separation is liquation on an iron plate or in a furnace. This process is only suitable for coarse borings, and absolutely useless for the finer grade material. Owing to the rapid accumulation of fine borings in the New South Wales railway workshops, it was necessary to devise a scheme for the recovery of these two classes of metal. This metal cannot be smelted straight out and used generally for castings, on account of the high antimony content—0.6 per cent."

"Under present conditions the borings taken from the machines are shaken on a ¼-in.-mesh sieve and the coarse white metal separated from the gunmetal by liquation on an iron plate. The removal of the white metal in the fine borings was the problem we were asked to solve. After a few experiments it was decided to pass the small borings from the bin to a magnetic separator, pick them up by a revolving belt fitted with pockets, and convey them to a bin above classifiers. From this bin the borings gravitate to classifiers and are separated into three grades. From bins Nos. 1 and 2 containing the coarser material, the borings gravitate on to a short revolving belt fitted with pockets and are delivered into a bin



Arrangement of Plant for Separation of White Metal from Gunmetal Borings.

above the furnaces and there gravitate to the furnaces. These furnaces are constructed of iron tubes, one fitting inside the other. The outer one being several inches larger in diameter than the inner one, is supported by means of brackets to the floor and carries in the intervening space between the two tubes, a coil of iron pipe with suitable size perforations for heating the walls of the inner tube by gas. The inner tube is revolved and the hot borings and liquid white metal pass into revolving screens smaller in mesh than the last classifier, and the liquid white metal mixed with the borings is allowed to escape through the screen into an outer vessel surrounding the screen, and which is heated by a gas coil. In this way the white metal does not cool, but collects at the bottom and can be run into moulds."

"The clean borings pass along the screen into a hand truck on wheels, which can be taken to the foundry and the borings smelted and utilised for ordinary gunmetal castings. The finest grade in No. 3 bin, which is only a small percentage of the total, will probably have to be smelted and the bulk of the antimony got rid of by oxidation."

Committees for the Supply of Munitions of War.

North-East Coast.

A meeting, called at the request of Lord Kitchener, was held at Newcastle last month, at which it was decided to appoint a representative Committee to mobilise the North-East Coast workers in order to accelerate the manufacture of munitions of war. The Trade Unions in the shipbuilding and engineering trades of the North-East Coast have chosen the following to represent them on the committee:—Messrs. G. J. Rowe, Boilermakers; J. Wile, Brassfounders and Finishers; Isaac Hebron, Patternmakers; Jas. Ratcliffe, Engineers; Ralph Spence, Union of Labour; Edward Gilbert, Blacksmiths; H. Crawforth, Shipwrights. At a representative meeting of the North-East Coast Engineering Trades Employers' Association, the following gentlemen were appointed to act on the Committee:—Mr. D. S. Marjoribanks, of Sir W. G. Armstrong, Whitworth & Company, Limited; Mr. Henry Clark, of G. Clark, Limited, Sunderland; Mr. M. S. Gibb, of the Central Marine Engine Works, West Hartlepool. Mr. M. C. James, managing director of the Mercantile Dry Dock Company, Limited, Jarrow, and chairman of the North-East Coast Ship Repairers' Association, has been selected as the ship repairers' representatives on the Committee. The representatives of the shipbuilders are Col. R. Saxton White (Messrs. Armstrong, Whitworth & Company, Walker); Mr. James Marr (Messrs. J. L. Thompson & Sons, Sunderland); and Mr. Leonard Ropner (Messrs. Ropner & Sons, Stockton).

These Committees have appointed sub-committees as follows:—

Engineering Sub-committee.—Employers' representatives: Engineers, Mr. W. S. Marjoribanks, Mr. Henry Clark, and Mr. Summers Hunter: shipbuilders, Colonel Saxton White, or Mr. J. Marr, or Mr. Leonard Ropner. Workmen's representatives: Engineering, Mr. J. Ratcliffe, Mr. E. Gilbert, and Mr. I. D. Hebron; shipbuilding, Mr. J. Wile.

Ship-repairing Sub-committee.—Employers: Ship-repairing, Mr. M. C. James; shipbuilding, Mr. J. Marr; and engineering, Mr. Summers Hunter or Mr. M. H. Gibb. Workmen: Ship-repairing, Councillor G. J. Rowe; shipbuilding, Mr. H. Crawforth; engineering, Mr. E. Gilbert.

Shipbuilding Sub-committee.—Employers: Shipbuilding, Colonel Saxton White, Mr. J. Marr and Mr. Leonard Ropner; engineering, Mr. Henry Clark or Mr. Summers Hunter or Mr. M. H. Gibb. Workmen: Shipbuilding, Mr. H. Crawforth, Councillor G. J. Rowe, and Mr. R. Spence; engineering, Mr. J. Ratcliffe.

Leeds.

The question of assisting the movement to obtain an unlimited supply of munitions of war was considered at a meeting of representatives of important engineering firms in the Leeds district on the 15th ult. After a brief discussion the appointment of the committee which had already been elected by the Employers' Federation to deal with the matter was confirmed by the general body of engineers present. The committee consists of the following gentlemen:—Mr. J. McLaren (Messrs. J. & H. McLaren), Mr. Bernal Bagshawe (Leeds Forge Company, Limited), Mr. A. Campbell (Hunslet Engine Company, Limited), Mr. Christopher James (J. Buckton & Company, Limited), and Mr. A. H. Meysey-Thompson (Hathorn, Davey & Company, Limited).

Manchester.

The Munitions Committee of Manchester has been formed from the Manchester Engineering Employers' Federation, and is now working with the War Office on the general scheme for providing labour where it is required.

Birmingham.

A similar meeting to the one reported above was held at Birmingham last month, Mr. F. Dudley Docker presiding. The Chairman stated that the Birmingham district included Wolverhampton, Coventry, Burton-on-Trent, and Worcester. An Executive Committee was formed, consisting of Mr. Dudley Docker as chairman, Sir Hallewell Rogers, Sir Gerard Muntz, Mr. Neville Chamberlain, Mr. Arthur Chamberlain, Mr. A. T. Keen, Mr. T. Harris Spencer (chairman of the Midland Employers' Federation), Mr. Steven (chairman of the Engineering Employers' Federation), Mr. E. V. Hiley (Town Clerk), and Captain R. S. Hilton (secretary). The Committee subsequently met and invited representatives of the following labour organisations to join them:—Amalgamated Society of Engineers, Workers' Union, and the Allied Trades Federation.

War Office Committee.

The War Office Armaments Output Committee comprises Lord Kitchener, Major-General Sir Stanley B. von Donop, Sir Herbert J. Walker, chairman of the Railways Executive Committee, Sir Algernon Firth, president of the Associated Chambers of Commerce, Mr. G. M. Booth, and Mr. Allan M. Smith, secretary to the Engineering Employers' Federation. The functions of the Committee are to arrange for the increase in the production of armament and munitions of war.

The Government's Committee.

In the House of Commons on Thursday, April 15, the Prime Minister announced the appointment of the committee to deal with the question of the supply of munitions of war. The function of the committee was to ensure the prompt and efficient application of all the available productive resources of the country for the manufacture and supply of munitions of war.

The committee is constituted as follows:—

Mr. Lloyd George (chairman).

Mr. Balfour.	Mr. Harold Baker.
Mr. A. Henderson.	Colonel Von Donop.
Mr. E. Montagu.	Admiralty Nominee.
Sir H. Llewellyn Smith.	Mr. G. M. Booth.

The committee had full authority to take all necessary steps for the purpose they had in view.

Mr. James Hope asked what were the relations between this and the larger committee.—The Prime Minister: The relations between the two are quite simple. This is a Departmental Committee of the War Office. The larger Committee deals with the whole question of the munitions of war.

The Workers' Committee.

The Board of Trade announce that in accordance with the memorandum of the proposals on the subject of the acceleration of the output on Government work, adopted at the recent conference between the Chancellor of the Exchequer and the President of the Board of Trade and representatives of a number of Trade Unions, an Advisory Committee, representative of the organised workers engaged in the production of Government requirements has been appointed for the purpose of facilitating the carrying out of the recommendations adopted at the conference, and for consultation by the Government or by the workmen concerned.

The Government have appointed the following to be members of the Committee:—

The Right Hon. Arthur Henderson, M.P. (chairman),
Mr. C. W. Bowerman, M.P.
Mr. Alexander Wilkie, M.P.
Mr. Frank Smith, J.P.
Mr. John Hill, J.P.
Mr. J. T. Brownlie.
Mr. W. Mosses (secretary).

The first meeting of the Committee was held on March 31, and was opened by Sir George Askwith.

Trade Talk.

THE Swedish Government has prohibited the export of ropes, cables, copper, and copper alloys.

PETTERS, LIMITED, engineers, of Yeovil, have established a branch at 52, St. Enoch Square, Glasgow.

MESSRS. JOHN THOMPSON, of Wolverhampton, have removed their London offices to Windsor House, Kingsway, W.C.

THE capital of the Willesden Foundry and Engineering Company, Limited, has been reduced from £6,000 to £2,700.

MR. A. TAYLOR, of Thames House, Queen Street, London, E.C., has been appointed receiver of the London Electron Works Company, Limited, London, E.C.

AN application for discharge will be made by Mr. W. H. Smith, brassfounder, 56, Goodman Street, Hunslet, Leeds, at the Leeds Bankruptcy Court on May 17.

A FIRE resulting in considerable damage has occurred at the Sheaf Ironworks, Lincoln, of Ruston, Proctor & Company, Limited. The fire was confined to the smiths' shop.

SRAWLEY, BROWETT, FRANCIS & COMPANY, LIMITED, are being wound up voluntarily, with Mr. W. Hutton, of Messrs. Charles Baker & Company, 39, Bennetts Hill, Birmingham, as liquidator.

AN explosion occurred on April 5 at the Parkhead Forge, Glasgow, of Wm. Beardmore & Company, Limited, during casting operations, and eleven men were more or less severely injured.

J. DUNLOP & COMPANY, LIMITED, have temporarily closed down their Calderbank Steel Works, by Airdrie, for alterations and repairs. Work should be resumed within a couple of months.

THE shareholders of the International Vanadium Company, Limited, have decided to wind up the company voluntarily. Mr. H. D. McAusland, of Liverpool, has been appointed liquidator.

THE announcement is made that the sale has been officially completed of the Ipswich works of the Consolidated Diesel Engine Manufacturers, Limited. The purchasers are Vickers, Limited.

THE council of the Associated Chambers of Commerce has been invited by the Director of Artillery to undertake an inquiry as to the capacity of British works to produce sheet brass for the manufacture of cartridge cases.

MESSRS. E. WALKER and J. BENNETT, carrying on business as templet makers, engineers and general mill furnishers, at Chesham Works, Chesham Street, Bradford, under the style of Walker & Bennett, have dissolved partnership.

FROM information received, it appears that the Admiralty will not make use of the old Cyfarthfa Iron and Steel Works for the manufacture of war munitions. We understand that the Dowlais works may be utilised in this respect.

THE ascertained net selling price of No. 3 Cleveland pig-iron for the months of January, February and March has been certified to have been 52s. 8.95d. per ton, as compared with 50s. 9.53d. per ton in the previous three months and 51s. 5.13d. per ton for the first quarter of 1914.

THE Scottish Steelmakers' Association are taking a census of all spare plant suitable for the production of ammunition, and particularly of shells. The result of the census, so far as ascertained, is to show that the productive capacity for the work is quite adequate for the purpose.

THWAITES BROS., LIMITED, Vulcan Ironworks, Bradford, have recently put down a furnace for the production of high-class steel castings, the whole of the output of which is at present being absorbed in the production of motor wheels. The wheels are machined and finished complete at the works.

THE average price of Scotch pig-iron warrants during March was 67s. 0¾d., compared with 62s. 6d. in February, 62s. in January, 58s 10¼d. in December, 55s. 11¼d. in November, 55s. 7¼d. in October, 57s. 1¾d. in September, 58s. 3¾d. in August, 57s. 3¼d. in July, and 56s. 6¼d. in March, 1914.

THE partnership heretofore subsisting between Messrs. W. Ingham and J. Gresty, carrying on business as engineers and machine brokers, at Cromwell Buildings, Blackfriars Street, Manchester, under the style of the Baldric Engineering Company, has been dissolved. Mr. Ingham will continue the business under the same style.

GALLOWAYS, LIMITED, of Manchester, have just cast the first of four bedplates for the large gas-blowing engines which they have on order for Palmers Shipbuilding and Iron Company, Limited, Jarrow. The casting, which necessitated the pouring of over 50 tons of metal, is the largest single casting which Messrs. Galloways have yet made.

MESSRS. T. BOULTON, W. BURLETSON, and E. WILSON, carrying on business as consulting engineers, at Exchange Buildings, Quayside, Newcastle-upon-Tyne, under the style of Thomas Boulton & Company, have dissolved partnership. Mr. W. Burletson and Mr. E. Wilson will continue the business under the style of Thomas Boulton & Company.

THE ASSOCIATION OF USERS OF DIESEL ENGINES, whose offices are at 19, Cadogan Gardens, London, S.W., has been established for the mutual benefit of those who have installed Diesel engines at their works. Meetings are held at the headquarters, when matters affecting the working of this type of motor are discussed and points of interest and value are exchanged.

A MEETING of the shareholders of the Molydenum and Tungsten Traders, Limited (in liquidation), will be held at the registered office of the Company, 638, Salisbury House, London Wall, E.C., on Wednesday, June 2, for the purpose of having an account laid before them, showing the manner in which the winding-up has been conducted and the property of the company disposed of.

MESSRS. J. EVANS, 35, Westfield Road, Manningham, Bradford, Squire Barraclough, 5, Warrington Place, Lidget Green, Bradford, and F. Cowie, 15, Flaxton Place, Lidget Green, Bradford, carrying on business as engineers, at Caledonian Street, Bradford, under the style of the Caledonian Engineering Company, have dissolved partnership, so far as regards Mr. James Evans.

THE WAR OFFICE MUNITIONS COMMITTEE announce that those companies who are at present manufacturing war material, armaments, etc., and who find their existing plant inadequate for the purpose, should communicate with Mr. G. M. Booth, Room 367, War Office, Whitehall, S.W. Particulars should be clearly stated of the plant required, the date by which it can be laid down, and the purpose for which it will be used.

AN "exchange meeting" in connection with the trade in hand tools and edged tools, organised in connection with the campaign initiated by the Board of Trade for assisting British manufacturers and traders to capture trade formerly in the hands of Germany and Austria-Hungary, was held on Thursday and Friday, April 15 and 16. Samples of German and Austro-Hungarian articles had been collected for the information of manufacturers.

SUBSCRIPTIONS have been invited for an issue of 80,000 6 per cent. cumulative preference shares of £1 each at par of Samuel Fox & Company, Limited. The company was formed in 1871 for the purpose of purchasing and carrying on the business (commenced in 1841) of Mr. Samuel Fox, at Stocksbridge Works, Deepcar, near Sheffield, with the steel works and other freehold and leasehold property, comprising crucible steel and Bessemer converting furnaces, rolling mills, collieries, etc.

SIR JOHN RANDLES, chairman of the Workington Iron and Steel Company, Limited, has written to the Maryport Council stating that there is no prospect of the firm restarting the Solway Ironworks, giving as a reason the high freights and the unsuitability of the works for the class of iron now being manu-

factured. The Council has made representations to a Government department suggesting the utilisation of the works for Government purposes, and a reply has been sent that the matter will have full consideration.

A DEPUTATION representative of Sheffield engineering employers and employés had an interview with Lord Kitchener's Committee at the War Office on April 22. The deputation was interviewed by Lord Kitchener in person. His Lordship expressed his high appreciation of the movement, which has for its aim the constitution of a joint committee of Sheffield masters and men, and paid a warm tribute to the great Imperial work which has been and is being done by industrial Sheffield.

DETAILS are now available of the scheme to purchase the Broken Hill Company's smelting works at Port Pirie, and the development of the iron and steel part of the company's business. A new company is to be formed with a nominal capital of £750,000 in shares of £1 each, of which £600,000 will be subscribed for in equal proportions by the three companies concerned, the Broken Hill Proprietary, the Broken Hill South Silver, and the North Broken Hill. Of this sum, £450,000, the purchase price, is payable to the Broken Hill Company.

SIR W. G. ARMSTRONG, WHITWORTH & COMPANY, LIMITED, announce that, having decided to extend their facilities for the manufacture of constructional steel work, they have arrived at an agreement with A. & J. Main & Company, Limited, of Glasgow, which places at their disposal much additional shop area. The work will be carried out as usual under their own supervision, and not only have they a representative on the board of A. & J. Main & Company, Limited, but they have a special technical staff of their own resident at Messrs. Main's works.

ACCORDING to the statistics issued by the Middlesbrough Chamber of Commerce, the make of pig-iron at furnaces within the port of Middlesbrough during the three months ended March 31, 1915, is estimated at the following, the output for the previous quarter and the corresponding period of 1914 being included for comparison:—

	Cleveland pig iron. Tons.	Hematite, spiegel, basic. Tons.	Total Tons.
Quarter ended March 31, 1915 ..	322,000	230,000	552,000
" " Dec. 31, 1914 ..	322,030	272,000	594,000
" " March 31, 1914 ..	330,000	300,000	630,000

DE BERGUE & COMPANY, LIMITED, of the Strangeways Ironworks, Manchester, inform us that for some time past they have had under consideration the necessity for remodelling and extending their works, and providing the additional working capital called for by the increased business. In order to carry these objects into effect, it has been decided, as being the most convenient and expeditious method under the circumstances, to wind up the company and to form a new company under the same name to take over the business as from March 31. There will be no alteration in the management. For this purpose Mr. F. V. Hansford, of 3, York Street, Manchester, has been appointed liquidator.

THE WILLINGSWORTH IRON COMPANY, LIMITED, of Wednesbury, Staffs., are responsible for a remarkably smart piece of work. The plant at Willingsworth consists of two blast furnaces, of which, normally, one is in blast. Recently it was found necessary to put the second furnace in service, the one blowing requiring re-lining. A very clean blow out was obtained, and the furnace was re-lined and re-lighted in a period of 32 days. This is probably a record for such work; in any case, it is a performance of which the management have every reason to be proud. In these days of labour troubles it is pleasing to be able to record the hearty co-operation of the men, practically all of whom rendered assistance. Many of them, notably the pig lifters, worked their ordinary turn and then put in extra time on the furnace.

THE manufacturers in the Birmingham metal trades are somewhat concerned regarding the immediate future of their business. Circulars which are being sent out from the various rolling firms in the city seem to indicate that the entire supply will be cut off from all manufacturers who are not employed on war material. A great number of the smaller firms have no facilities for turning out shells, fuses, or other armament required by the military authorities, and if the embargo is maintained some scores of factories will have to be shut, as the stocks held in the majority of cases are only very small. Already orders for metal are being returned to consumers, with the intimation that they cannot be fulfilled unless a certificate is given that the metal is required for the completion of a Government contract.

WHAT is undoubtedly the largest single order given by any Government since the war began has been placed by Russia with the Canadian Car and Foundry Company, whose plant is at Montreal, and Amherst, Nova Scotia. The order is said to be practically without limit, and the company has already sub-let to Canadian and American manufacturers under the contract orders for shells in excess of £6,400,000. The contract runs for a year, and is only limited to the capacity of the mills of Canadian and United States manufacturers. Shipments will be made *viâ* Halifax and Archangel, Halifax, Panama Canal and Vladivostock, *viâ* rail to the Pacific Coast and Vladivostock and the Siberian Railway, and from New York and other United States ports. Large shipments of shells from Canada *viâ* the Pacific route have been going forward for some time.

Applications for Patents.

An asterisk indicates that a complete specification accompanies the application. When inventions are communicated the names of the communicators are in brackets.

2,125 & 2,126. Composite pattern plates for use in sand moulding. L. Hill.
2,219.*Process of Bessemerizing copper matte. J. B. Herreshoff.
2,220.*Combined apparatus for melting and casting metal. I. Hall.
2,389.*Process of alloying zinc with iron or steel. B. F. Dimm.
2,395.*Tilting wagons. Naamlooze Vennootschap Constructie-werkplaatsen voorheen du Croo & Brauns.
2,433. Process for the manufacture of finely-divided metals. S. O. Cowper-Coles.
2,578. Composition for lining crucibles and the like to withstand intense heat. J. B. Sidebottom.
2,619. Electric starters for internal-combustion engines. A. H. Midgley and C. A. Vandervell.
2,621.*Hearth furnaces for melting metals. E. Bosshardt.
2,639. Treating iron and steel ingots. B. Talbot.
2,683. Cast-iron flange joint. W. G. Carter.
2,692.*Process for producing metallic coatings. G. Stolle.
2,804. Oil-fuel furnaces. C. M. Shaw.
2,852. Squirting or pressing lead, tin, lead-tin, and similar alloys. J. Mitchell.
3,035.*Metal furnaces. I. Hall.
3,036.*Metal furnaces. I. Hall.
3,427.*Manufacture of steel alloys. Soc. Anon des Aciéries et Forges de Firminy.
3,786.*Heat treatment of manganese steel. Manganese Steel Rail Company.
3,874. Metal-melting furnaces. I. Hall.
3,953. Electric furnaces. E. K. Scott and F. Howles.
3,976. Casting metals. Royce, Limited, and W. C. M. Matterson.
4,228. Manufacture of metal ingots. Sir Robert A. Hadfield and A. G. McK. Jack.
4,325. Recovery of metals from slags. C. Vautin.
4,455.*Manganese alloys. Th. Goldschmidt Akt.-Ges.
4,615. Purification of tungsten and tungsten compounds. P. Perrino and G. Sesti.

Personal.

THE late Mr. John Bateman, engineer, of Abbey Road, Darlington, left estate valued at £6,365 gross.

MR. J. M. FALKNER has been elected vice-chairman of Sir W. G. Armstrong, Whitworth & Company, Limited.

THE first directors of J. Concord & Company, Limited, are Mr. J. Flower, Mr. T. H. Firth, and Mr. G. H. Firth.

MR. J. SUGG has been appointed chief engineer to the Davis Gas Stove Company, Limited, in place of Mr. H. C. Turner, retired.

THE gross value of the estate of the late Mr. W. Froggatt, chief engineer at the Thorncliffe Ironworks, Sheffield, is £3,803.

THE late Mr. F. Newton, a director of W. T. Henley's Telegraph Works Company, Limited, left estate valued at £24,861 gross.

MR. W. DOIG GIBB, chief engineer of the South Metropolitan Gas Company, has resigned that position in consequence of ill-health.

THE late Mr. J. C. Ridley, steel manufacturer, of Newcastle, left estate valued at £4,558 0s. 7d. gross, with net personalty £3,609 5s. 11d.

THE late Mr. A. MCOSTRICH, J.P., a director of the Queenstown Dry Docks, Shipbuilding, and Engineering Company, Limited, left personal estate valued at £346,403.

IN the absence on active service of Dr. G. D. Bengough, now a captain in the Royal Garrison Artillery, the council of the Institute of Metals have appointed Mr. W. E. Gibbs, his assistant, as acting honorary investigator to the Corrosive Committee.

SIR PERCY GIROUARD has resigned his seat on the board of Sir W. G. Armstrong, Whitworth & Company, Limited, he having been gazetted temporary major-general. Last week the Chancellor of the Exchequer stated in the House of Commons that the Government were under a considerable debt of gratitude to Sir Percy for organising the transfer of men from other engineering concerns to armament works.

MANY of our readers who were acquainted with Captain Paul Delalande when he was the representative in this country of the French Foundrymen's Association, will be interested to learn that he is now Captain in the 10th Regiment de Génie. He has been wounded three times, and has been presented with the Stanilas Cross (Russian Order) for valour on the battlefield. He was conspicuous in the fighting in Alsace-Lorraine, particularly at Woevre.

THERE was an interesting ceremony at the meeting of the Cleveland Institution of Engineers at Middlesbrough on April 12, the President (Sir Thomas Wrightson, Bart.), in the chair. Mr. A. B. Gridley said that owing to the war they had been unable to celebrate their jubilee as an Institution by a banquet over which the President would have presided. But it was felt that they could not allow his great kindness in accepting the Presidency to go without some little mark of appreciation, and he had, therefore, very much pleasure in asking Sir Thomas Wrightson, on behalf of the Institution, to accept the very excellent framed portrait of himself as a record of his presidency in the Jubilee Session of 1914-15. The portrait bore the inscription:—"Sir Thomas Wrightson, Bart., President of the Cleveland Institution of Engineers, Jubilee Session, 1914-1915."

THE BRITISH BINDERIT COMPANY, LIMITED, makers of the well-known "Binderit" compound for moulding and core sands, who recently acquired new works on the Thames to cope with the increasing demand for their products, have now got those works into full working order. To facilitate the transaction of business the offices of the company have been removed from Southampton House, Holborn, W.C., to the works, and communications should in future be addressed to Binderit Works, Wharf Road, Wandsworth, S.W. The telephone number is Putney, 994.

New Companies.

J. Sloper & Company, Limited.—Capital £25,000 in £1 shares, to carry on the business of engineers.

Pembridge Engineering and Contract Company, Limited.—Capital £1,000 in £1 shares, to enter into an agreement with A. J. Swanton.

Ellaways, Limited.—Capital £3,000 in £1 shares, to carry on the business of ironfounders. Registered office:—52, Spencer Street, Birmingham.

British Tool & Engineering Company, Limited.—Capital £5,000 in £1 shares (2,000 preference). Registered office:—Owen Road, Wolverhampton.

Walsall Foundry Company, Limited.—Capital £5,000 in £1 shares (2,000 preference), to carry on the business of iron and brass founders, etc.

Rossol Engine Syndicate, Limited.—Capital £600 in £1 shares (569 "A" and 31 "B"). Registered office:—28, Great James Street, Bedford Row, W.C.

Tower Metal Company (London), Limited.—Capital £1,000 in £1 shares (500 preference). Registered office: 1, Guildhall Chambers, Basinghall Street, E.C.

Moore & Attwood, Limited.—Capital £500 in £1 shares, to carry on the business of founders, casters, etc. Registered office: Canton Works, Young Street, Sheffield.

Hatherton Works Company, Limited.—Capital £4,000 in £1 shares, to carry on the business of iron, steel, brass, aluminium and other metal founders, etc.

Newton Brothers (Derby), Limited.—Capital £31,000 in £1 shares (1,000 employés), to carry on the business of engineers. Registered office: 21, Market Place, Derby.

Gilbert Netherwood & Company, Limited.—Capital £400 in £1 shares, to take over the business of engineers, etc., carried on by Gilbert Netherwood & Company at Bridge Works, Turnbridge, Huddersfield.

Bristol Rock Drill and Engineering Company (1915), Limited.—Capital £2,000 in £1 shares, to carry on the business indicated by the title and that of ironfounders, etc. Secretary (pro tem.): J. F. Gumm. Registered office: 26, New Station Road, Fishponds, Bristol.

A. Robinson & Company, Limited.—Capital £15,000 in £1 shares (7,000 pref.), to take over the business of mechanical and electrical engineers, etc., carried on at Knowsley Road, Bootle, Lancs., as A. Robinson & Company, and to adopt an agreement with P. R. Keppie.

The Comptoir Metallurgique et Industriel, Limited.—Capital £5,600 in £800 shares, to carry on the business of metallurgists, manufacturers, dealers and suppliers of arms, ammunition, and war material, general contractors to H.M. War Department and Admiralty and Allies. The first directors are G. Baseil, E. Dubois, C. Pelabon, E. Petersson, and F. van der Linden. Registered office: 28, Victoria Street, London, S.W.

Carntyne Iron and Steel Company, Limited.—Capital £20,000 in 15,000 6 per cent. cumulative preference and 5,000 ordinary shares of £1 each, to acquire and carry on the business of the Carntyne Iron Company, Parkhead, Glasgow. Subscribers:—Edward Martin Stewart, coalmaster and firebrick manufacturer, 68, West Regent Street, Glasgow; and Matthew Reid, iron manufacturer, Dalgarne, South Dalziel Road, Motherwell. Registered office: 187, West George Street, Glasgow.

British Metal (Kingston), Limited.—Capital £15,000 in £1 shares (5,000 per cent. cumulative preference), to carry on the business of ironfounders, etc. Pursuant to the Trading with the Enemy (Amendment) Act, the Board of Trade has licensed the acquisition by this company of the undertaking of the British Metal Engraving Company, Limited, which undertaking is liable to inspection under Section 2 (2) of the principal Act. The first directors are W. D. G. Bennet, H. A. Farman, C. B. Charlesworth, and J. S. Charlesworth. Registered office: 47, Eden Street, Kingston-on-Thames.

Deaths.

Mr. Robert Allan, of the firm of Aitken & Allan, engineers, 37, Holyrood Square, Edinburgh, died recently.

The death is reported of Mr. H. J. Bakewell, late Engineer-Inspector at the Admiralty, at the age of 82 years. He retired about 15 years ago.

Mr. W. Disston, head of Henry Disston & Sons, Inc., steel and saw manufacturers, of Philadelphia, U.S.A., died recently at the age of 56 years.

The death has occurred in the United States of Mr. F. W. Taylor, the inventor with the late Mr. M. White, of the Taylor-White high-speed metal-cutting steels. He was 59 years of age.

The death has occurred of Mr. J. B. A. Légé, engineer and scientific instrument-maker, of 47, Lofting Road, N., and 11, Milner Street, Chelsea, S.W. Mr. Légé was a contractor to the Admiralty, War Office, Board of Trade, India and Colonial Offices, etc.

Mr. J. McC. Caldwell Paton has died at his residence, Western Terrace, the Park, Nottingham. The deceased gentleman was the managing director of Manlove, Alliott & Company, Limited, engineers, and was a member of the Institution of Mechanical Engineers. He was 62 years of age.

The death took place recently of Mr. R. Wigram, of Leeds, and at one time a director of John Fowler & Sons, Limited. The deceased gentleman was 70 years of age, and retired from the directorship of Messrs. Fowlers' some years ago, being succeeded by his younger son, Mr. W. G. Wigram.

The death occurred on April 12 of Mr. J. Wilson, at his residence, Snaithing Brook, Sheffield. Mr. Wilson devoted a considerable part of his time to the business of Messrs. Spear & Jackson, edge tool and implement manufacturers, Ætna Works, Savile Street, Sheffield, of which he was principal.

The death is announced from New York, at the age of 59 years, of Mr. F. W. Taylor, widely known as an efficiency expert, and as the originator of the modern system of scientific works management. The deceased, in conjunction with another steel expert, was also the inventor of a process for treating high-speed cutting tools.

We regret to announce the death of Professor D. A. Louis, which took place recently at a London nursing home after a long illness. Professor Louis was a consulting mining engineer. He was a graduate of the Royal School of Mines, and had had varied experience in metal mining. For some time he acted as Professor of Mining at the Yorkshire College, Leeds. He was the author of several papers read before the Iron and Steel Institute and other learned bodies.

Mr. E. L. Ljungberg, head of the largest and most extensive industrial company in Sweden, the Stora Kopparbergs Bergslags A.-B., at Falun, died on April 5, in Stockholm, aged 72 years. With him has passed away one of the most able men Sweden has ever had in her realm of industry and trade. He had been since 1875 at the head of the Stora Kopparbergs Bergslag, and was particularly well known and a frequent attendant at the meetings of the Iron and Steel Institute.

Mr. George Greig Moncur, of Mackenzie & Moncur, Limited, engineers and ironfounders, Edinburgh, Glasgow and London, died at Edinburgh recently, aged 76 years. The business was established by Mr. Mackenzie and Mr. Moncur in 1869 in a very small way, and was converted into a limited liability company 21 years ago, the capital being increased to £100,000 about a dozen years ago, when the foundry of Messrs. Mackenzie Brothers, Slateford Road, Edinburgh, was acquired.

Information has been received in Wales of the death of a prominent Welsh American, Mr. John H. Lloyd. The deceased was born at Dowlais in 1859, and served an apprenticeship with the Dowlais Iron Company, subsequently becoming associated with the Tredegar Ironworks. In 1882 he went to America, and obtained a position at Alliance, Ohio, in the engineering department of the Morgan Company. He subsequently rose to be general manager of the concern, a position he held at his death.

Mr. Joseph Maddison, general secretary of the Friendly Society of Ironfounders, died recently, at Somercotes. Mr. Maddison occupied the position of assistant general secretary of the Society for 7½ years (1886 to 1894), and then general secretary for 14½ years, thus establishing a record for length of service in the general office of the Society. He was a well known and respected figure in Trade Union circles, and for a considerable period was treasurer of the General Federation of Trade Unions. He was also a member of the Mosely Commission which visited America in 1902, to report on the trade in that country.

Mr. Thomas Cumberland died on April 18 at his residence, "Ferndale," Perry Barr, Birmingham. The deceased was one of the oldest and best-known figures in the Midland iron trade. He was in his 82nd year, and had been in failing health for some time past, but until comparatively recently he was a regular attendant at the weekly iron trade meeting on the Birmingham Exchange. He was a member of the firm of Sutton & Ash, iron and steel merchants, Snow Hill, Birmingham, and a director of William Roberts, Limited, Tipton Green Blast Furnaces. For several years he had acted as chairman of the Wholesale Traders' Association (for the hardware, furnishing, and metal industries).

The death has occurred at Newton Abbot, Devonshire, of Mr. J. A. MacLellan, a director of the firm of Alley & MacLellan, Limited, engineers and shipbuilders, Glasgow. Mr. MacLellan, who was 61 years of age, had practically retired from business and had been in residence in the South of England for several years. He was one of the founders of the now well-known Sentinel Works at Polmadie, and bore a large share in the development of the concern to its present proportions. After being trained as an engineer in Glasgow he embarked on this enterprise when he was only about 21 years of age. The only other partner in the business at its inception and for many years afterwards was the late Mr. Stephen Alley. The firm was converted into a limited liability company in 1903, and Mr. MacLellan was elected one of the directors.

Mr. T. A. Bayliss, chairman and managing director of the King's Norton Metal Company, Limited, died suddenly on April 21, at St. Leonards-on-Sea. Mr. Bayliss, who resided at St. John's, Warwick, was well known and respected in the public and commercial life of Birmingham and the neighbourhood. He was the son of Mr. Thomas Richard Bayliss (who died in July last), and in conjunction with his father founded the firm of the King's Norton Metal Company in 1889, the business being converted into a limited company shortly afterwards. Together they perfected a machine designed to improve the methods of casting, rolling, and general working of metals for ammunition, and they manufactured the first six-pounder case for the Nordenfeldt gun which was adopted by the British Government.

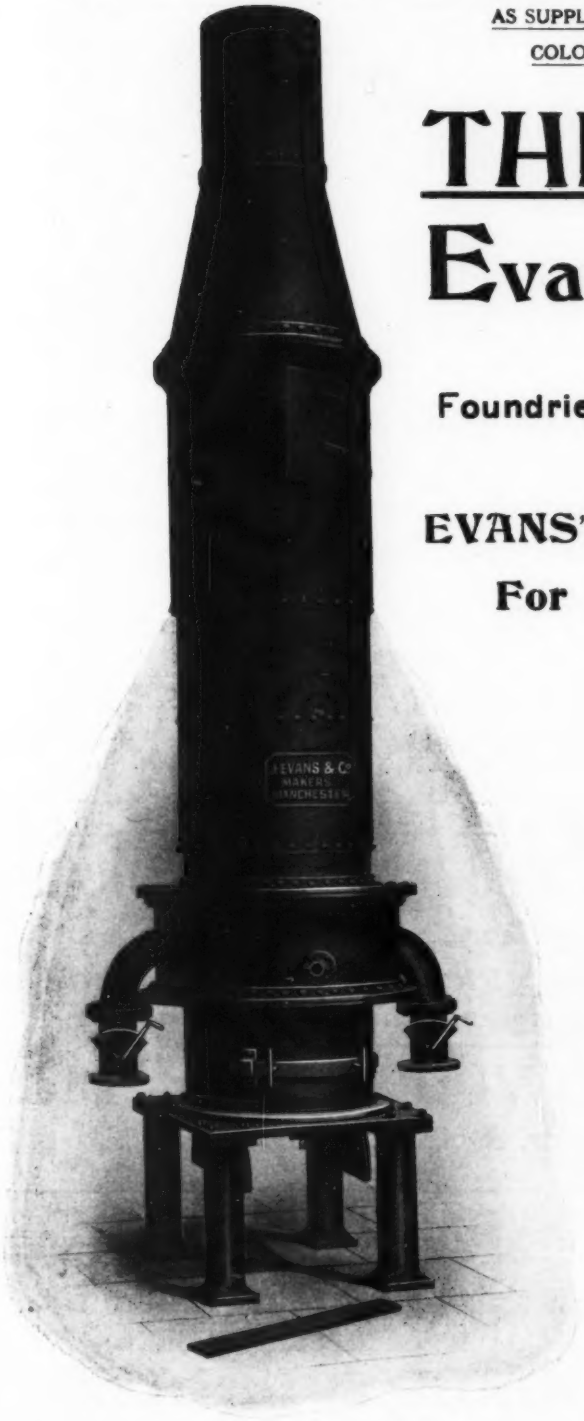
The monthly mineral circular issued by Sir S. W. Royse & Company, Limited, of Manchester, states that imports of iron ore showed well in March, but the returns for the first quarter of this year are 262,188 tons less than for the first quarter of 1914. Some moderate amount of new business has lately been arranged, but consumers do not care to buy forward to any considerable extent at current rates. Manganese ore is steady without much new business; some consumers are disposed to hold off, hoping for some easing in values through improved prospects of a resumption of shipments from Russia. For pyrites there is plenty of demand, but not much outside ore offering.

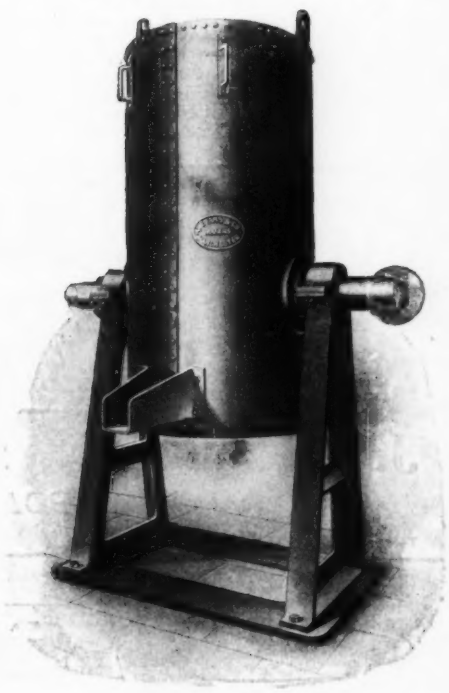
AS SUPPLIED TO THE ADMIRALTY, WAR OFFICE, COLONIES, AND FOREIGN GOVERNMENTS.

THE Cupola. Evans's Rapid.

Foundries Completely Furnished.

EVANS'S NEW CUPOLETTE
For Emergency Work.





James Evans & Co.,
Britannia Works,
Blackfriars,
MANCHESTER.

Telegrams: "LADLES, MANCHESTER,"
Telephone: 2297 CENTRAL, MANCHESTER.

Parliamentary Notes.

Contracts with German Firms.

MR. O'GRADY asked the Attorney-General last month, whether he was aware that firms in this country having a contract with German firms, although signed in Germany, for the delivery of goods here, the delivery of which in consequence of the war was rendered impossible, were having to get their goods manufactured in this country, and when the war was over would be legally compelled to accept delivery of the goods from German firms within the terms of the original contract; and, if so, would steps be taken to safeguard British firms from any legal proceedings that might ensue

SIR J. SIMON (Attorney-General) said the hon. member would recollect that the Legal Proceedings Against Enemies Act was recently passed for the express purpose of providing a solution to problems similar to this. The solution depended on the facts of each case; but he would not have thought the consequences suggested by the hon. member would necessarily follow in the circumstances mentioned.

SIR A. B. MARKHAM said learned counsel's opinion had been taken, and it was to the directly opposite effect.

SIR J. SIMON said he had no doubt that any opinion that could be given would be given on a full statement of the facts. All he would say was that if the facts were as stated in the question he was surprised that the conclusion should be as suggested.

Government Steel Purchases.

Last month MR. RONALD M'NEILL inquired of the Under Secretary for War, whether any Government contracts had been given to a German named Kuehnrich, residing at Holly Court, near Sheffield: whether this man owned or controlled the business where Julius Wurscher, an enemy alien of military age, was employed until his recent conviction for an offence against the Defence of the Realm Act; if he was aware that it was Kuehnrich who paid the fine of £100 inflicted on Wurscher for that offence: whether Kuehnrich had procured the release of certain interned alien enemies of military age, including one Klein, who falsely represented himself to be of Swiss nationality; whether any aliens so released had been permitted to leave the country; and whether any investigation had been made as to the antecedents and character of Kuehnrich?

MR. TENNANT: Small quantities of a special steel have been obtained from the London agents of a firm in which Kuehnrich is interested, but this steel is now being obtained from other sources. It is, I believe, the case that Kuehnrich controls the firm for which Wurscher was working. I have no means of knowing whether the fine was paid by Kuehnrich or not. The Department has no knowledge of Kuehnrich having procured the release of interned aliens.

INSTITUTE OF INDUSTRY AND SCIENCE.—The Institute of Industry and Commerce recently changed its name, and is now styled the "Institute of Industry and Science." The word "commerce," it is explained, has been dropped in order not to confuse the Institute with other existing Associations, and also to more clearly define the objects of the Institute in its title. The Institute of Industry and Science is meant to be a counterpart of a German organisation known as the Hansa Bund, which is in reality a Chamber of manufacturers', shippers', and trade organisations, *i.e.*, a confederation of important German firms for promoting encouraging and facilitating German industry, commerce and the expansion of foreign trade. The Hansa Bund is, however, of a somewhat political character, inasmuch as it may be said to be attached to the German Liberal Parliamentary party as opposed to the Junker policy. The Hansa Bund was founded in 1909, and has its head office in Berlin, with a large branch at Hamburg.

GANISTER, CUPOLA BLOCKS, FIRE BRICKS,
FIRE CLAY.
Silica Bricks, Tuyeres, Stoppers, Nozzles, &c.
STEEL MOULDERS' COMPOSITION, SILICA CEMENT.
J. GRAYSON LOWOOD & Co., Ltd.,
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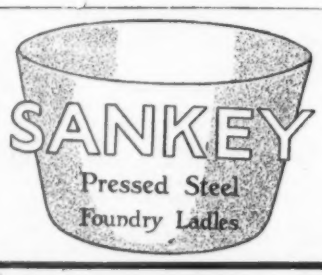

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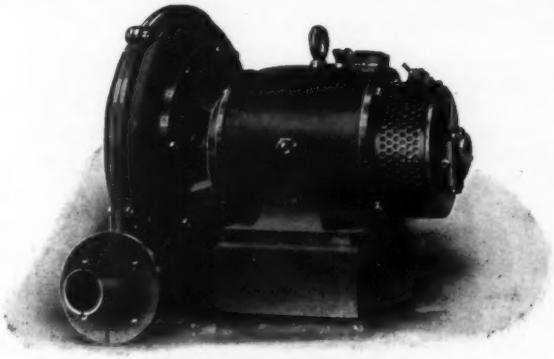
SEAMLESS PRESSED STEEL
FOUNDRY LADLES
Plain or Lipped: Made in any capacity from ½ cwt. to 4 cwts. Write for Details.
JOSEPH SANKEY & SONS LTD., HADLEY, SALOP.



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TRADE SIROCCO MARK

High Pressure Fans

Are made in a large number of sizes from 10 in. diameter upwards.

Bulletins 2000 F. and 2028 F.

Some Points worth noting.

Owing to few wearing parts, the Fans are not liable to break down. The mechanical efficiency is high and remains so. The pressure is steady and the volume even and free from pulsations.

Davidson & Co., Ltd.,

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BELFAST.

ELDERS FOUNDRY COKE

AS SUPPLIED TO THE BRITISH ADMIRALTY DOCKYARDS.

The following, selected from numerous letters, are eminent testimony as to the quality of our celebrated "A.A.A." Coppee Foundry Coke, carefully selected, and despatched in sheeted wagons.

From PECKETT & SONS, Bristol.

Bristol, October 25th, 1904.

We have been using your Selected Foundry Coke for some considerable time.
We have pleasure in stating that we are very pleased with it, as we find we get sounder and cleaner castings, more free from blowholes and other defects, than we formerly did.

From BOW, McLACHLAN & CO., LTD. (Paisley Foundry), Paisley, Glasgow.

Paisley, 12th March, 1909.

We have yours of 4th inst., and in reply have pleasure in stating that we have been using your Foundry Coke for several years for special purposes with highly satisfactory results.

Elders Collieries, Ltd., Cardiff.

Telegraph: "ELDER, CARDIFF." **Telephone: 4640 & 4641.**

MONTHLY PRICE LIST.

The undermentioned prices, unless otherwise specified, are those obtaining on the first day of the current month.

Pig-iron.

Cleveland.

	May 1. s. d.
Cleveland No. 1	67 9
,, No. 3	65 9
,, No. 4 foundry	65 3
,, No. 4 forge	64 9
,, Mottled	64 3
,, White	64 3
East Coast hematite, mixed Nos.	102 6
Cleveland warrants	65 7

Above prices are for early f.o.b. deliveries and as regards Cleveland iron are for G.M.B. brands. The warrant quotations are the sellers cash prices.

Scotland.

	s. d.
Standard Foundry (Glasgow Market settlement price)	64 7½
Warrants, ditto	71 0

Makers' prices:—	s. d.		s. d.
Gartsherrie No. 1	85 0	No. 3	80 0
Coltness No. 1	102 0	No 3	82 0
Summerlee No. 1	85 0	No. 3	80 0
Langloan No. 1	85 0	No. 3	80 0
Calder No. 1	85 0	No. 3	80 0
Clyde No. 1	85 6	No. 3	80 6
Carnbroe No. 1	83 6	No. 3	79 6
Monkland No. 1	81 0	No. 3	79 6
Shotts No. 1	85 0	No. 3	80 0
Govan No. 1	79 0	No. 3	77 6
(All deliverable alongside Glasgow.)			
Glengarnock No. 1	86 6	No. 3	81 6
(Deliverable alongside Ardrossan.)			
Dalmellington No. 1	82 0	No. 3	80 0
Eglinton No. 1	80 0	No. 3	79 0
(Deliverable alongside Ayr.)			
Carron No. 1	86 0	No. 3	81 0
(F.a.s. Grangemouth.)			

Lancashire.

	s. d.	s. d.
Lancashire No 3 foundry f.o.t.	—	—
Lincolnshire No. 3 foundry	75 9	76 9
Derbyshire No. 3 foundry	—	72 6
Staffordshire No. 3 foundry	—	72 6
Cleveland No. 3 foundry	—	—
(All delivered equal Manchester.)		
Scotch No. 3 — Gartsherrie	—	88 6
Scotch No. 3 — Glengarnock	—	87 0
Scotch No. 3 — Eglinton	—	87 0
Scotch No. 3 — Summerlee	—	87 0
(Delivered Manchester Docks.)		

North-West of England.

	s. d.	s. d.
Bessemer mixed numbers net f.o.b.	—	1?2 6
Hematite warrant net cash	—	95 0
Lorn cold-blast charcoal iron	180 0	190 0

The Midlands.

	s. d.	s. d.
Staffs. — Common forge	—	65 0
Staffs. — Part Mine forge	70 0	71 0
Staffs. — Best All Mine	87 6	90 0
Staffs. — Cold Blast	—	135 0

Strong forge, about 1s. less than grey forge; Mottled and White, about 2s. less than forge; Foundry No. 3, 3s. to 5s. above forge; No. 1 and No. 2, from 1s. 6d. to 2s. above No. 3; No. 1, about 2s. above No. 2.

Northampton foundry	—	—
North Staffs. foundry	—	—
Derby foundry	—	—
Nottinghamshire foundry	—	—
Leicestershire foundry	—	78 6
Shropshire Cold-Blast	—	135 0

(Delivered South Staffordshire Works, net cash monthly.)

Lincolnshire.

	s. d.	s. d.
Forge	—	—
Grey forge	—	—
Basic	—	—
No. 3 foundry	—	—
No. 4 foundry	—	—

F.o.s. Makers' works.

South Wales.

	s. d.	s. d.
Welsh Hematite	—	102 6

Ferro-Alloys.

Net, Delivered Sheffield Steel works.

	£ s. d.
Ferro-chrome: 4/6% carbon. Basis 60%, scale 10s. per unit. Per ton	28 0 0
Ferro-chrome: 6/8% carbon. Basis 60%, scale 10s. per unit. Per ton	26 10 0
Ferro-chrome: 8/10% carbon. Basis 60%, scale 8s. 6d. per unit. Per ton	25 0 0
Ferro-chrome: Specially refined, guaranteed maximum 2% carbon, broken to small pieces for use in best quality crucible steels. Basis 60%, scale 22s. per unit. Per ton	70 0 0
Ferro-vanadium: 33/40% Va., per lb. of Va. contained in the alloy	0 9 0
Ferro-silicon: 45/50%. Basis 50%, 5s. scale per unit .. Per ton	14 15 0
Ferro-titanium: 15/18%, per pound, flat	0 0 6½
Ferro-molybdenum: 70/80% Mo. per pound of Mo. contained	0 18 0
Ferro-phosphorus: 20/25%. Per ton	16 10 0
*Ferro-manganese 80%	15 0 0
,, export	—

* F.o.b. Liverpool.

Iron Castings.

Cleveland.

	£ s. d.	£ s. d.
Columns (plain)	7 7 6 to	7 12 6
Pipes, 1¼ to 2½ in.	7 0 0	7 5 0
,, 3 to 4 in.	6 10 0	6 15 0
,, 5 to 8 in.	6 5 0	6 7 6
,, 10 to 16 in.	6 5 0	—
,, 18 to 24 in.	6 5 0	—
Chairs	4 7 6	4 10 0
Floor plates (open sand)	3 10 0	3 12 6

(At work).

Non-Ferrous Metals.

Copper.	May 3. £ s. d.	£ s. d.
Standard, Cash	76 7 6	76 12 6
Three months	77 17 6	78 2 6
Electrolytic	86 10 0	87 10 0
Tough	86 0 0	87 0 0
Best selected	86 0 0	87 0 0

Tin.		
Standard, Cash	162 10 0	163 0 0
,, ,, Three months	164 5 0	164 15 0
English Ingots	—	165 0 0
Bars	—	166 0 0
Refined	—	168 0 0

Spelter.		
American	—	67 0 0
Specials	—	—
Hard	—	47 0 0
British	—	67 0 0

Lead.		
Soft foreign	—	20 15 0
English	—	22 0 0

Antimony.		
Regulus	—	97 10 0

Aluminium.		
Virgin Metal, 98/99%	per ton	86 0 0

*Chromium (Metallic).		
98/99% purity	per lb.	—

*Nickel.		
In cubes, 98/99% purity	Per ton	220 0 0

*Tungsten Metal Powder.		
96/98% purity	per lb.	0 6 0

*Molybdenum Metal.		
96/98% purity	per lb.	—

*Cobalt Metal.		
97% purity	per lb.	0 7 6

Quicksilver.		
75 lb. bottle		11 18 9

* Net, Delivered Sheffield Works.

Scrap Iron and Steel.

Cleveland.

	s. d.	s. d.*
Steel scrap, heavy melting	67 6 to	70 0
Iron scrap cast (cupola metal)	57 6	60 0

London (f.o.b.).

Heavy steel	62 6
Light	50 0
Heavy cast	62 6

Non-Ferrous Scrap.

London merchants quote the following prices for scrap metal, delivered London, and subject to market fluctuations: —

	A. Joseph £ s. d.
Hy. Electrolytic Copper Scrap	84 0 0
Hy. Selected Scrap Brass	60 0 0
Hy. Tinned Copper Wire	75 0 0
Best Selected Gunmetal Scrap	70 0 0

Re-melted Ingot Lead 15s. under English Lead price on date of order.

Stocks.

Pig-iron in Public Store.

	Apl. 29. Tons.	Inc. + or Dec. — since Apl. 30. 1914. Tons.
Connal's at Glasgow Scotch	1,000	No change.
Ditto other makes	—	— 2
Connal's at Middlesbrough	140,737	+ 50,088
Connal's at Middlesbrough, hematite	—	No change.
West Coast hematite	2,457	— 5,636

Metals.

Copper, Europe and afloat	31,487	+ 2,209
Tin, London, Holland, U.S.A. and afloat	17,949	+ 875

Coke.

Middlesbrough.

	s. d.	s. d.
Gas Coke	unobtainable.	
Foundry Coke	40 0 to	42 6
Furnace coke	—	27 6

Newcastle-on-Tyne.

FOUNDRY COKE—	f.o.b. s. d.	Dunston s. d.
Original Garesfield	—	40 0
Mickley	—	40 0
Stella Garesfield	—	40 0
Priestman's Garesfield	40 0 to	41 0
Consett Garesfield	40 0 to	41 0
Newcastle gas coke	—	20 4

Cardiff.

	s. d.	s. d
Special foundry coke	42 0 to	45 0
Foundry coke	36 0 to	40 0
Furnace coke	30 0 to	33 0

Leeds.

Furnace coke (washed)	22 0 to	23 0

Birmingham.

Foundry coke	—	—
Furnace ,,	—	—
Gas ,,	—	—

Glasgow.

Foundry coke	— 30 0
Furnace ,,	— 24 0
Gas ,,	— 15 6

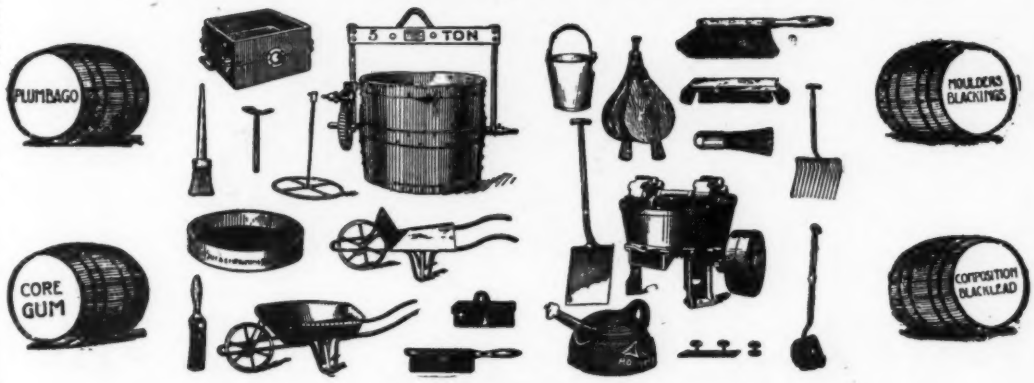
London.

Foundry coke	—	—
Gas coke (Beckton), into barge	—	—
,, ,, into wagon at Works	—	—
Gas coke, Provincial (London sidings)	—	—

Established 1863.

JAS. DURRANS & SONS,

Phœnix Works, Penistone, Near Sheffield.



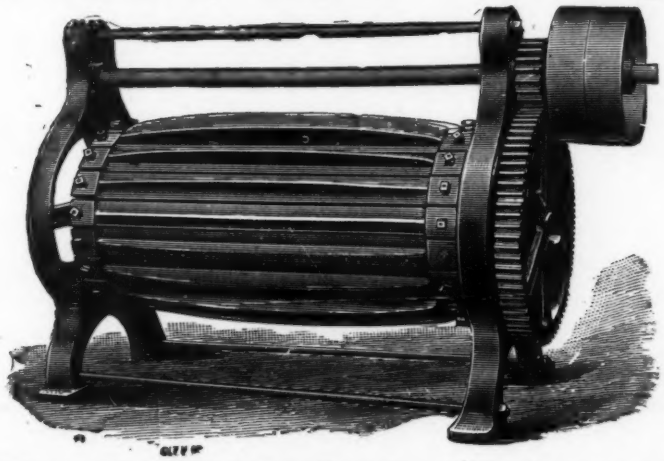
Manufacturers of all

FOUNDRY EQUIPMENTS

COMPOSITION BLACK LEAD, PLUMBAGO, CORE GUM, WHITE DUST & COAL DUST

Ladles, Cupolas, Fire Bricks, Gannister, Stone Flux, Loam and Sand Mills, Casting Cleaners, Studs, Chaplets, Pipe Nails, Sprigs, Brushes, Wire Brushes, Core Ropes, Bellows, Buckets, Spades. Forks, Riddles, Sieves, Barrows, Etc.

Improved Foundry Rattler or Fettling Drum.



These Machines are invaluable for a Foundry, doing a larger amount of work of a superior quality, in a much shorter time than can be done by hand, without skilled labour.

The following testimonial explains itself :—

"Dear Sirs,—We have been using your best Blacking for a large number of years, and always use it on our large Ingot Moulds, which, as you know, we have made up to 85 tons in weight.

Yours faithfully, THE BRIGHTSIDE FOUNDRY & ENGINEERING CO., LD.

Patent Sand Mixer

Uses up more old sand than has hitherto been considered possible.

Our Patent Sand Mixer has the following desirable advantages.

The sand is thoroughly aerated, rendered light and loose in texture and of even temper.

Previous milling of the sand is unnecessary.

Seven hundredweights of sand dealt with per minute.

All bearings are ball bearings.

All gears are casehardened steel.

All gears and bearings run in an oil-bath rendering them practically everlasting.

Cages easily examined and cleaned.

Cages do not clog as there are no curved passages.

Machines can be seen in operation in our foundries, Edgwick, Coventry.

ALFRED HERBERT, Limited,

Coventry.

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FOUNDRY FOREMAN wanted immediately for London Ironfoundry. Must be a thoroughly practical Moulder, with good general foundry experience, and used to control of men. Good position for capable man.—Write, stating age, previous experience, and salary required, to Box 564, c/o Offices of THE FOUNDRY TRADE JOURNAL, 165, Strand, London, W.C.

ENERGETIC IRON FOUNDRY FOREMAN (52), accustomed to high-class heavy Engineering Castings in Dry and Green Sand, desires change. Could take entire charge of Foundry, and invest £100 if desired.—Apply Box 558, Offices of THE FOUNDRY TRADE JOURNAL, 165, Strand, London, W.C.

IRON FOUNDRY TRAVELLER.—Wanted, for an up-to-date Foundry Department of a large Engineering Firm in the neighbourhood of London, a first-class energetic man. Qualifications: Thorough knowledge of the trade, sound, live connection, able and willing to break new ground. Output of Foundry 250 tons weekly. Weight of Castings up to 35 tons each.—Apply in confidence, stating full particulars of training, experience, age and salary required, to 1674, SELL'S Advertising Offices, Fleet Street, London.

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TO BRASS FOUNDERS AND OTHERS.—For SALE, almost new HAND MOULDING MACHINE, SAND MILL, ROTARY SIEVE, First-Class GAS ENGINE, LATHES, and other Machines.—Apply Box 490, Offices of THE FOUNDRY TRADE JOURNAL, 165, Strand, London, W.C.

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MOULDING MACHINE.

(HYDRAULIC or PNEUMATIC)

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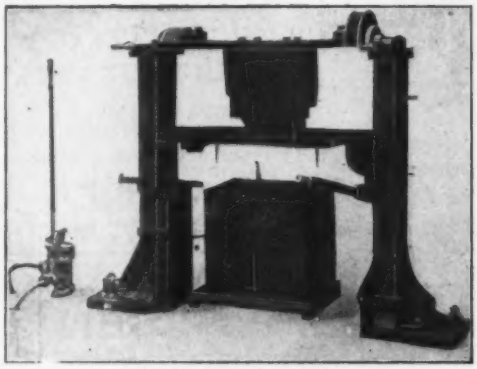

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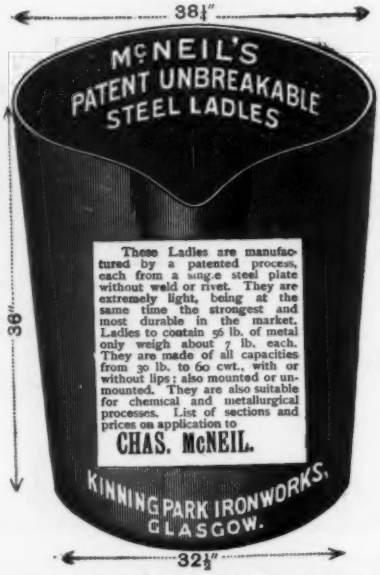
THE "CHIPCHASE" PATENT JARRING MACHINE.

THE "CHIPCHASE" PATENT CORE MAKING MACHINE.

Sole Makers—

DAVID BRIDGE & Co., Ltd.,

CASTLETON FOUNDRY, CASTLETON, MANCHESTER.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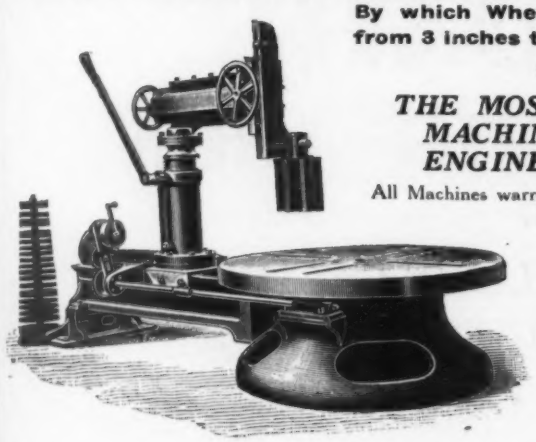

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